Poultry Farming

Poultry Production and Breeding

Textbook for Class XI

Paper I

Poultry Farming

POULTRY PRODUCTION AND BREEDING

Textbook for Class XI

Paper I

D. C. JOHARI
R. C. HAZARY

A. K. SACHETI
Project Coordinator

PANDIT SUNDERLAL SHARMA CENTRAL INSTITUTE OF VOCATIONAL EDUCATION
राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

February 2001
Magha 1922

PD 5T BB

OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus	108, 100 Feet Road, Hosdakere	Navjivan Trust Building	CWC Campus
Sri Aurobindo Marg	Halli Extension, Banashankari III Stage	P.O.Navjivan	32, B.T. Road, Sukchar
NEW DELHI 110 016	BANGALORE 560 085	AHMEDABAD 380 014	24 PARGANAS 743 179

Rs 24.00

Published at the Publication Division by the Secretary, National Council of Educational Research and Training, Sri Aurobindo Marg, New Delhi 110 016, lasertypeset inhouse at PSSCIVE, Bhopal and printed at M/s Tarang Printers, B-50, Kishan Kunj, Ext. Part II, Delhi 110 092.

FOREWORD

Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE) has taken up an important and innovative project of development of curricula and instructional materials for vocational courses on the advice of the Joint Council of Vocational Education. It proposes to develop/revise competency-based curricula and bring out textbooks, practical manuals, audio and video materials, etc. for every course in existence or courses proposed to be introduced at a later date in the higher secondary vocational education system.

The present title shows the commendable work done by the Institute in meeting the requirements of instructional materials for students and teachers. Developed through a comprehensive mechanism, the title is the product of significant contributions made by several experts and others. This has been duly acknowledged in this book elsewhere. All communications and observations on this project should be sent to the Joint Director, PSSCIVE, Bhopal.

J. S. RAJPUT
Director
National Council of Educational
Research and Training

NewDelhi
February 2001

PREFACE

The National Policy on Education (1986) envisages that the introduction of a systematic, well-planned and rigorously implemented programmes of vocational education is crucial in the proposed educational reorganisation. In support of this, a variety of programmes or courses have been introduced under Centrally sponsored schemes at the lower secondary, higher secondary and college levels.The programme at the +2 stage has assumed a big shape.

Paucity of appropriate instructional materials (textbooks and practical manuals) is one of the major constraints in implementation of the programme and a source of great hardship to the students offering vocational courses at the higher secondary stage. To supply these, several efforts have been made in the past by the erstwhile Department of Vocationalisation of Education, NCERT, New Delhi and by state governments. A review of efforts by the PSSCIVE, Bhopal revealed that there was a wide gap between the supply of relevant books for the number of vocational courses and actual requirements. To fill this gap, the PSSCIVE, Bhopal has taken up a project of developing and publishing a variety of instructional resource materials. The work of this project is being implemented through the mechanism of working groups constituted for each course. It includes (i) review of existing curricula and instructional materials, (ii) adoption or adaptation of existing books and (iii) fresh writing of books.

The present book entitled *Poultry Production and Breeding, Textbook* is based on the competence-based curriculum developed by PSSCIVE, Bhopal and fulfils 80-90 per cent requirement of any particular state syllabus. The book was earlier developed by outside experts for the state of Karnataka in a project coordinated by the Educational Consultants India; Limited. It was then reviewed by a Working Group consisting of experts formed by the Institute.

I am grateful to the author and the members of the Working Group for in particular who reviewed and revised this manuscript. Their names are given elsewhere.

I place on record my appreciation for the untiring efforts put in by Dr M. K. Salooja, Project Co-ordinator of the Working Group Meeting in planning and organising several such meetings that led to this final form of this title.

I shall be grateful for any suggestions and observations from readers, which would help in bringing out a revised and improved version of this book.

S.Z. HAIDER
Joint Director
Pandit Sunderlal Sharma
Central Institute of Vocational Education

Bhopal
February 2001

ACKNOWLEDGEMENTS

AUTHORS :

1. Dr. D. C. Johari, Head (Retd.), Division of Avian Genetics and Breeding, Central Avian Research Institute, Izat Nagar 243 122, Bareilly, Uttar Pradesh
2. Dr. R. C. Hazary, Senior Scientist, Project Directorate on Poultry, Rajendra Nagar, Hyderabad 500 030, Andhra Pradesh

PSSCIVE WORKING GROUP :

Members :

1. Prof. J. N. Panda, Director (Retd.), CARI, Padhupada, Balasore 756 001, Orissa.
2. Dr. P. C. Panda, Professor and Ex-Dean (COAS), Animal Products Technology, CCS Haryana Agriculture University, Hissar 125 004, Haryana.
3. Dr. D. C. Johari, Head (Retd.), Division of Avian Genetics and Breeding, Central Avian Research Institute, Izat Nagar 243 122, Bareilly, Uttar Pradesh
4. Dr. A. G. Khan, Professor and Head (Retd.), Poultry Science Department, JNKVV, Krishi Nagar, Jabalpur, Madhya Pradesh.
5. Dr. H. K. Pradhan, Professor, High Security Animal Disease Laboratory HSADL, IVRI Unit, Anand Nagar, Bhopal 462 021, Madhya Pradesh.
6. Dr. S. K. Gumashta, M. V. Sc. (Poultry Science), Veterinary Assistant Surgeon, Govt. Poultry Farm, MACT Road, Mata Mandir, Bhopal 462 006, Madhya Pradesh.
7. Dr. M.K. Salooja, Reader, Division of Agriculture, Area of Vocation, PSSCIVE (NCERT), 131, Zone-II, M.P. Nagar, Bhopal 462 011, Madhya Pradesh (Presently working at IGNOU, New Delhi).

CONTENTS

CHAPTER 1

Indian Poultry Industry with Reference to Agricultural Farming

Poultry farming in India was mostly a backyard venture almost up to 1960. The scientific poultry keeping in India was first initiated and advocated by Christian missionaries, who introduced small flocks of improved breeds from their countries. The performance of these birds was certainly better than the *desi* flocks and this attracted the attention of Government officials to introduce several model poultry farms in various parts of the country. During the last three decades the entire scenario of poultry farming in India has changed. It is now recognized as scientifically based well organized industry with tremendous employment potential and as a tool to fight poverty and malnutrition.

The term poultry although very often used as synonymous to chicken, includes a number of avian species such as chicken, duck, turkey, guinea fowl and geese, etc. Chicken and ducks are kept for commercial production of both eggs and meat. Turkey, guinea fowl, geese, etc. are maintained for meat. Chicken the most popular domesticated poultry accounts for about 90% of the total poultry production of the country. Ducks, next to chicken in order of preference, account for 9 %. Commercial poultry farming involving turkey, guinea fowl, geese, etc. is practically non-existent. Although recently introduced, quail farming for egg and meat is becoming very popular.

1.1 Poultry Industry

The production statistics of Indian poultry industry are presented in Table 1.1 and 1.2. During the last three decades, annual output of eggs has gone up by over eight time to 2,36,600 million, making poultry the fastest growing sector of Indian agriculture. The seventies saw a spurt in egg production: the eighties in broiler production (from 30 to 190 million); and the nineties promises to be the decade of poultry processing.

India, with an annual production of 34 billion eggs in 1999, ranks as the world's fifth largest egg producing country after China, Former USSR, USA and Japan. The performance of commercial chicken in India is comparable to that obtained anywhere

TABLE 1.1
Annual Production and per Capita Availability of Eggs, Broiler and Poultry Meat, 1961-1996.

Year	Production			Per capita availability	
	Eggs (million)	Broiler (million)	Poultry Meat (000 tones)	Eggs (no.)	Poultry meat (g)
1961	2881	0	81	7	188
1971	5340	4	121	10	220
1980	12500	30	179	18	266
1985	16128	75	274	22	365
1990	23300	190	412	28	498
1991	23660	215	440	28	521
1992	22740	210	427	26	493
1993 (est)	24800	235	454	28	517
1994 (ant)	26290	275	507	29	566
1995 (proj)	28130	330	578	31	633
1996 (proj)	30000	400	659	32	707

Source : Poultry Industry Year Book -1994

in the world. The genetically-bred hen lays on an average 270 eggs per year. Over 50 % of egg and broiler production comes from just four States - Andhra Pradesh, Maharashtra, Punjab and Tamil Nadu. One major challenge before the industry is to spread poultry production in villages.

The broiler population, which was only four million in 1971, was estimated to exceed 700 million in 1999. This rapid increase is not only due to the cheapness of the broiler meat but also to its wide acceptibility, increased public concern regarding health and diet and the development of value added and processed poultry products. The annual egg production which was about 2,881 million in 1961 is estimated to have exceded 24,800 million in 1993. It is interesting to note that, while egg production increased by more than eight fold during the last 30 years, the corresponding increase in poultry population was only 2.34 fold. This reflects a reduction in the number of indigenous desi fowl and their replacement by modern laying stock which has greatly enhanced productivity. According to industry sources, egg and broiler production are currently growing at the rates of more than 10 and 20 % per year, respectively.

TABLE 1.2
Estimated Laying Stock and Egg Production, 1961-96. (in million)

Year	Layers			Eggs		
	Desi	Improved	Total	Desi	Improved	Total
1961	61	3	64	2861	20	2881
1971	50	12	62	2280	3060	5340
1980	64	37	101	2875	9625	12500
1985	72	50	122	3325	12903	16128
1990	78	76	154	3495	19805	23300
1991	79	77	156	3549	20111	23660
1992	76	74	150	3411	19329	22740
1993 (est)	66	84	150	2974	21826	24800
1994 (ant)	70	89	159	3154	23136	26290
1995 (proj)	75	95	170	3375	24755	28130
1996	73	103	176	3300	26700	30000

Source : Poultry Industry Year Book-1994.

The Five Year Plan expenditure on animal husbandry and poultry between 1951-1990 and outlay till 1997 are presented in table 1.3. The Five Year Plan outlays on poultry in the last 38 years reflects the fast rate of growth of the industry. The government investment on poultry amounted to about Rs. 28 million in the Second Plan and about Rs. 602 million during Seventh Plan.

The value of poultry production has climbed steeply-eight times under the impact of modernization from about Rs.8,000 million in 1980-81 to Rs.63,400 million in 1993-94. A part of this increase was due to inflation. The contribution of chicken meat to the total poultry has been rising more rapidly than that from eggs. The contribution from both the subsectors i.e. eggs and chicken meat was at the same level in 1980. The poultry meat sector had almost doubled in 1993; eggs, Rs. 21,900 million; Poultry, Rs. 41,500 million.

Now the most important challenge of the 21st century is access to food rather than availability. Towards this end, the income and employment potential of rural poor as well as small and marginal farmers and landless labourers need to be enhanced. Poultry in particular offers a vast scope for generating income in economically backward classes. With proper management of financial and manpower resources, poultry can give the needed momentum and direction to the aspirations of the large majority of people

TABLE 1.3
Five Year Plan Expenditure on Animal Husbandry and Poultry between 1951-1990 and Outlay till 1997 (Rs. million)

Plan period	Total Plan expenditure	Agriculture and allied activities	Expenditure on animal husbandry and dairying	Expenditure on poultry
First Plan (1951-56)	19,600	2,900	160.0	N.A.
Second Plan (1956-61)	46,720	5,490	334.7	28
Third Plan (1961-66)	85,770	10,890	770.0	46
Annual Plan (1966-69)	66,254	11,071	597.0	N.A.
Fourth Plan (1969-74)	157,790	23,204	1,542.6	115
Fifth Plan (1974-78)	394,262	48,665	2,324.6	355
Annual Plan (1978-80)	121,765	19,997	2,087.7	N.A
Sixth Plan (1980-85)	1,092,917	136,203	8,025.1	426
Seventh Plan (1985-90)	2,202,163	279,611	12,805.0	602
Eighth Plan	4,341,000	568,926	28,383.2	N.A.

N.A : Not available
Source : Poultry Industry Year Book-1994.

for improving their standard of living.

Despite these impressive achievements and prospects, a large gap exists between the current egg production and the minimum needs of the country. The per capita availability is only 34 eggs and 700 grams poultry meat per year. As per recommendation of the Nutrition Advisory Committee of the Government of India, a daily intake of at least half an egg per person is essential. On this basis, India's minimal demand of eggs per year exceeds 160,000 million. The current output, however, is less than 16 % of this figure. National Institute of Nutrition recommends a per capita consumption of 10.8 kg of total meat per annum. The per capita consumption of eggs in India is barely 34 (1999) as against 60-70 for the developing countries and 300 for developed countries. The per capita poultry meat consumption in India is only 700 g (1999) per year as compared to 2.5 kg for developing countries and 15.6 kg for developed countries. So this gap calls for many fold increase

in both egg and meat production before the end of this century to meet the demand of the growing population of this country.

1.2 Poultry and Agricultural Farming.

Since centuries poultry keeping is an integral part of rural based agricultural farming. It is a source of daily household income and provides nutritional input of animal origin, offered as sacrifice to God, and acts as a meat source in festival days.

With an improvement of technical knowledge on agricultural by-products as rice polish, wheat bran, oil cakes (i.e. groundnut, sesame, safflower, linseed, cotton-seeds mustard, and soybean meal, etc.) which were previously used to feed cattle or recycled (some of them) in the field as manure are now utilized in the poultry feeding. Consequently in general about 60% of the total ingredients in the poultry rations are now agricultural by-products.

Apart from above relationship between agriculture and poultry keeping, industrialization of poultry opened new avenues in strengthening its relationship with agriculture with reference to fertilization of soil by using poultry excreta. Poultry excreta contains about 29% protein, 1,600 kcal gross energy, low in fibre content and is a source of valuable amino-acids and manure. Poultry and duck manure are excellent source of food to fish culture and sericulture. It can also be used in floriculture and horticulture as an excellent source of micro-minerals and organic manure. Therefore poultry is utilizing not only agricultural by-products but also is a potent agent of recycling of mineral excreta in the fields to improve soil fertility. Poultry can also act as an important income generating small scale industry to marginal and landless agricultural labourers. The advantage could further be increased if systematic approach could impart basic skills of poultry production to youths and women folk in rural areas.

QUESTIONS

1. Give a brief account of development of poultry industry in India.
2. Tick the correct answer (√)
   (a) Chicken accounts for 90% of total poultry production. T/F
   (b) Ducks account for 9% of poultry production. T/F
   (c) Annual output of egg production in India is 34 billion per year (1999). T/F
   (d) Estimated broiler production is about 700 million. T/F
   (e) Per capita availability of eggs in India is about 34 eggs. T/F

TABLE 1.3
Five Year Plan Expenditure on Animal Husbandry and Poultry between 1951-1990 and Outlay till 1997 (Rs. million)

Plan period	Total Plan expenditure	Agriculture and allied activities	Expenditure on animal husbandry and dairying	Expenditure on poultry
First Plan (1951-56)	19,600	2,900	160.0	N.A.
Second Plan (1956-61)	46,720	5,490	334.7	28
Third Plan (1961-66)	85,770	10,890	770.0	46
Annual Plan (1966-69)	66,254	11,071	597.0	N.A.
Fourth Plan (1969-74)	157,790	23,204	1,542.6	115
Fifth Plan (1974-78)	394,262	48,665	2,324.6	355
Annual Plan (1978-80)	121,765	19,997	2,087.7	N.A
Sixth Plan (1980-85)	1,092,917	136,203	8,025.1	426
Seventh Plan (1985-90)	2,202,163	279,611	12,805.0	602
Eighth Plan	4,341,000	568,926	28,383.2	N.A.

N.A : Not available
Source : Poultry Industry Year Book-1994.

for improving their standard of living.

Despite these impressive achievements and prospects, a large gap exists between the current egg production and the minimum needs of the country. The per capita availability is only 34 eggs and 700 grams poultry meat per year. As per recommendation of the Nutrition Advisory Committee of the Government of India, a daily intake of at least half an egg per person is essential. On this basis, India's minimal demand of eggs per year exceeds 160,000 million. The current output, however, is less than 16.% of this figure. National Institute of Nutrition recommends a per capita consumption of 10.8 kg of total meat per annum. The per capita consumption of eggs in India is barely 34 (1999) as against 60-70 for the developing countries and 300 for developed countries. The per capita poultry meat consumption in India is only 700 g (1999) per year as compared to 2.5 kg for developing countries and 15.6 kg for developed countries. So this gap calls for many fold increase

in both egg and meat production before the end of this century to meet the demand of the growing population of this country.

1.2 Poultry and Agricultural Farming

Since centuries poultry keeping is an integral part of rural based agricultural farming. It is a source of daily household income and provides nutritional input of animal origin, offered as sacrifice to God, and acts as a meat source in festival days.

With an improvement of technical knowledge on agricultural by-products as rice polish, wheat bran, oil cakes (i.e. groundnut, sesame, safflower, linseed, cotton-seeds mustard, and soybean meal, etc.) which were previously used to feed cattle or recycled (some of them) in the field as manure are now utilized in the poultry feeding. Consequently in general about 60% of the total ingredients in the poultry rations are now agricultural by-products.

Apart from above relationship between agriculture and poultry keeping, industrialization of poultry opened new avenues in strengthening its relationship with agriculture with reference to fertilization of soil by using poultry excreta. Poultry excreta contains about 29% protein, 1,600 kcal gross energy, low in fibre content and is a source of valuable amino-acids and manure. Poultry and duck manure are excellent source of food to fish culture and sericulture. It can also be used in floriculture and horticulture as an excellent source of micro-minerals and organic manure. Therefore poultry is utilizing not only agricultural by-products but also is a potent agent of recycling of mineral excreta in the fields to improve soil fertility. Poultry can also act as an important income generating small scale industry to marginal and landless agricultural labourers. The advantage could further be increased if systematic approach could impart basic skills of poultry production to youths and women folk in rural areas.

QUESTIONS

1. Give a brief account of development of poultry industry in India.
2. Tick the correct answer (√)
   (a) Chicken accounts for 90% of total poultry production. T/F
   (b) Ducks account for 9% of poultry production. T/F
   (c) Annual output of egg production in India is 34 billion per year (1999). T/F
   (d) Estimated broiler production is about 700 million. T/F
   (e) Per capita availability of eggs in India is about 34 eggs. T/F

TABLE 1.3
Five Year Plan Expenditure on Animal Husbandry and Poultry between 1951-1990 and Outlay till 1997 (Rs. million)

Plan period	Total Plan expenditure	Agriculture and allied activities	Expenditure on animal husbandry and dairying	Expenditure on poultry
First Plan (1951-56)	19,600	2,900	160.0	N.A.
Second Plan (1956-61)	46,720	5,490	334.7	28
Third Plan (1961-66)	85,770	10,890	770.0	46
Annual Plan (1966-69)	66,254	11,071	597.0	N.A.
Fourth Plan (1969-74)	157,790	23,204	1,542.6	115
Fifth Plan (1974-78)	394,262	48,665	2,324.6	355
Annual Plan (1978-80)	121,765	19,997	2,087.7	N.A
Sixth Plan (1980-85)	1,092,917	136,203	8,025.1	426
Seventh Plan (1985-90)	2,202,163	279,611	12,805.0	602
Eighth Plan	4,341,000	568,926	28,383.2	N.A.

N.A : Not available
Source : Poultry Industry Year Book-1994.

for improving their standard of living.

Despite these impressive achievements and prospects, a large gap exists between the current egg production and the minimum needs of the country. The per capita availability is only 34 eggs and 700 grams poultry meat per year. As per recommendation of the Nutrition Advisory Committee of the Government of India, a daily intake of at least half an egg per person is essential. On this basis, India's minimal demand of eggs per year exceeds 160,000 million. The current output, however, is less than 16.% of this figure. National Institute of Nutrition recommends a per capita consumption of 10.8 kg of total meat per annum. The per capita consumption of eggs in India is barely 34 (1999) as against 60-70 for the developing countries and 300 for developed countries. The per capita poultry meat consumption in India is only 700 g (1999) per year as compared to 2.5 kg for developing countries and 15.6 kg for developed countries. So this gap calls for many fold increase

in both egg and meat production before the end of this century to meet the demand of the growing population of this country.

1.2 Poultry and Agricultural Farming

Since centuries poultry keeping is an integral part of rural based agricultural farming. It is a source of daily household income and provides nutritional input of animal origin, offered as sacrifice to God, and acts as a meat source in festival days.

With an improvement of technical knowledge on agricultural by-products as rice polish, wheat bran, oil cakes (i.e. groundnut, sesame, safflower, linseed, cotton-seeds mustard, and soybean meal, etc.) which were previously used to feed cattle or recycled (some of them) in the field as manure are now utilized in the poultry feeding. Consequently in general about 60% of the total ingredients in the poultry rations are now agricultural by-products.

Apart from above relationship between agriculture and poultry keeping, industrialization of poultry opened new avenues in strengthening its relationship with agriculture with reference to fertilization of soil by using poultry excreta. Poultry excreta contains about 29% protein, 1,600 kcal gross energy, low in fibre content and is a source of valuable amino-acids and manure. Poultry and duck manure are excellent source of food to fish culture and sericulture. It can also be used in floriculture and horticulture as an excellent source of micro-minerals and organic manure. Therefore poultry is utilizing not only agricultural by-products but also is a potent agent of recycling of mineral excreta in the fields to improve soil fertility. Poultry can also act as an important income generating small scale industry to marginal and landless agricultural labourers. The advantage could further be increased if systematic approach could impart basic skills of poultry production to youths and women folk in rural areas.

QUESTIONS

1. Give a brief account of development of poultry industry in India.
2. Tick the correct answer (√)
   (a) Chicken accounts for 90% of total poultry production. T/F
   (b) Ducks account for 9% of poultry production. T/F
   (c) Annual output of egg production in India is 34 billion per year (1999). T/F
   (d) Estimated broiler production is about 700 million. T/F
   (e) Per capita availability of eggs in India is about 34 eggs. T/F

TABLE 1.3
Five Year Plan Expenditure on Animal Husbandry and Poultry between 1951-1990 and Outlay till 1997 (Rs. million)

Plan period	Total Plan expenditure	Agriculture and allied activities	Expenditure on animal husbandry and dairying	Expenditure on poultry
First Plan (1951-56)	19,600	2,900	160.0	N.A.
Second Plan (1956-61)	46,720	5,490	334.7	28
Third Plan (1961-66)	85,770	10,890	770.0	46
Annual Plan (1966-69)	66,254	11,071	597.0	N.A.
Fourth Plan (1969-74)	157,790	23,204	1,542.6	115
Fifth Plan (1974-78)	394,262	48,665	2,324.6	355
Annual Plan (1978-80)	121,765	19,997	2,087.7	N.A
Sixth Plan (1980-85)	1,092,917	136,203	8,025.1	426
Seventh Plan (1985-90)	2,202,163	279,611	12,805.0	602
Eighth Plan	4,341,000	568,926	28,383.2	N.A.

N.A : Not available
Source : Poultry Industry Year Book-1994.

for improving their standard of living.

Despite these impressive achievements and prospects, a large gap exists between the current egg production and the minimum needs of the country. The per capita availability is only 34 eggs and 700 grams poultry meat per year. As per recommendation of the Nutrition Advisory Committee of the Government of India, a daily intake of at least half an egg per person is essential. On this basis, India's minimal demand of eggs per year exceeds 160,000 million. The current output, however, is less than 16.% of this figure. National Institute of Nutrition recommends a per capita consumption of 10.8 kg of total meat per annum. The per capita consumption of eggs in India is barely 34 (1999) as against 60-70 for the developing countries and 300 for developed countries. The per capita poultry meat consumption in India is only 700 g (1999) per year as compared to 2.5 kg for developing countries and 15.6 kg for developed countries. So this gap calls for many fold increase

in both egg and meat production before the end of this century to meet the demand of the growing population of this country.

1.2 Poultry and Agricultural Farming

Since centuries poultry keeping is an integral part of rural based agricultural farming. It is a source of daily household income and provides nutritional input of animal origin, offered as sacrifice to God, and acts as a meat source in festival days.

With an improvement of technical knowledge on agricultural by-products as rice polish, wheat bran, oil cakes (i.e. groundnut, sesame, safflower, linseed, cotton-seeds mustard, and soybean meal, etc.) which were previously used to feed cattle or recycled (some of them) in the field as manure are now utilized in the poultry feeding. Consequently in general about 60% of the total ingredients in the poultry rations are now agricultural by-products.

Apart from above relationship between agriculture and poultry keeping, industrialization of poultry opened new avenues in strengthening its relationship with agriculture with reference to fertilization of soil by using poultry excreta. Poultry excreta contains about 29% protein, 1,600 kcal gross energy, low in fibre content and is a source of valuable amino-acids and manure. Poultry and duck manure are excellent source of food to fish culture and sericulture. It can also be used in floriculture and horticulture as an excellent source of micro-minerals and organic manure. Therefore poultry is utilizing not only agricultural by-products but also is a potent agent of recycling of mineral excreta in the fields to improve soil fertility. Poultry can also act as an important income generating small scale industry to marginal and landless agricultural labourers. The advantage could further be increased if systematic approach could impart basic skills of poultry production to youths and women folk in rural areas.

QUESTIONS

1. Give a brief account of development of poultry industry in India.
2. Tick the correct answer (√)
   (a) Chicken accounts for 90% of total poultry production. T/F
   (b) Ducks account for 9% of poultry production. T/F
   (c) Annual output of egg production in India is 34 billion per year (1999). T/F
   (d) Estimated broiler production is about 700 million. T/F
   (e) Per capita availability of eggs in India is about 34 eggs. T/F

CHAPTER 2

Important Breeds of Poultry

The word poultry includes wide varieties of birds of several species like fowls, ducks, turkeys, guinea fowl, quails, etc.

2.1 Fowls

The domestic fowl belongs to genus *Gallus*. The characteristics of this genus are, short, stout and curved beak, one or two wattles, a large comb, feet suitable for scratching and tail laterally compressed. In fact the only characteristic, that rarely distinguishes the genus is the comb. The genus includes, four species of wild or jungle fowl. viz. *Gallus gallus* (Red jungle fowl), *Gallus lafayettii* (Ceylon jungle fowl) *Gallus sonneratii* (Grey jungle fowl) and *Gallus varius* (Javan jungle fowl). While some believe that all the present-day domestic breeds of poultry have originated from red jungle fowl, others are of the opinion that, two or more of the existing four wild species of fowl are responsible for the same.

Fowls may be classified in a variety of ways. Sir Edward Brown, classified based on the purpose for which they are developed such as egg type, meat type and dual purpose (for both egg and meat). But it is mostly classified on the basis of their geographical origin. Such as American class, Asiatic class, English class and Mediterranean class.

2.1.1 American Class

The breeds of American class have been bred for both egg and meat production. Most important of them are Plymouth Rock, New-Hampshire, Rhode Island Red, Jersey Black Giant and Wyandotte. Birds in this class do not have feathers on the shank, they all have yellow shank and skin and red ear lobes. They all lay brown-shelled eggs. except Holland breed which produces white-shelled eggs.

2.1.1.1 Plymouth rock

The Plymouth Rock produces eggs of a good size and have got good fleshing property. Barred and White Plymouth Rocks are very popular. White Plymouth Rock with a long body of good depth and a broad and prominent breast is especially favoured for broiler production. The breed has a single comb (Fig 2.1).

Barred Plymouth Rock possesses greyish-white plumage. The feathers

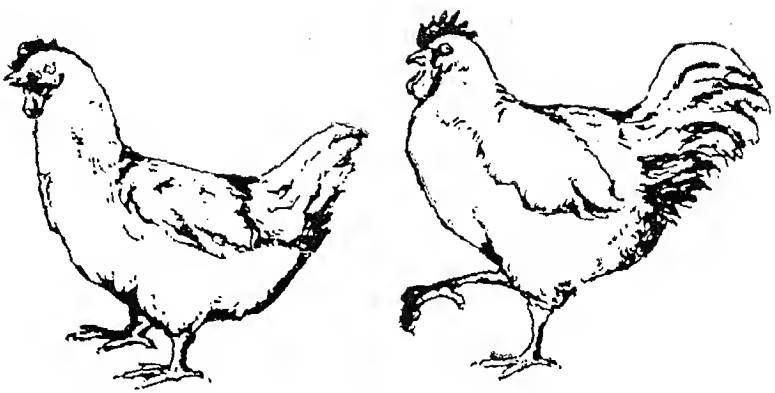


Fig 2.1 Plymouth rock male and female

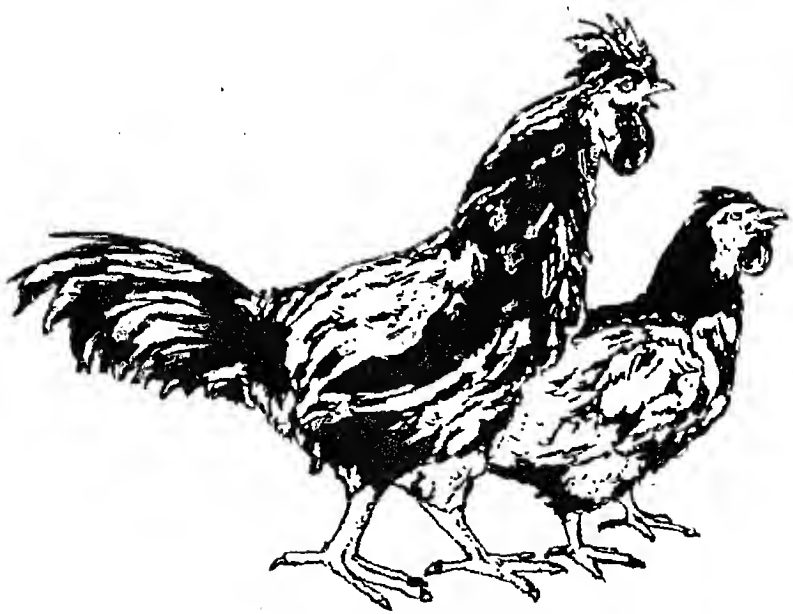


Fig 2.2 Rhode Island red male and female

are crossed by black bars, even in width, straight and extend down to the skin.

Standard weight:	Cock	4.3
in kg	Hen	3.4
	Cockerel	3.6
	Pullet	2.7

2.1.1.2 Rhode Island red

The Rhode Island Red is a dual-purpose breed developed in Rhode Island in America. Single and rose-comb are the two common varieties. Single-comb Rhode Island Red strains are popular for commercial production of brown-shelled eggs. The characteristic features of the breed are long body, broad and deep breast carried well forward, flat back with red eyes and red ear lobes. Legs and feet are deep yellow but may show brown colour. The male is dark red with black tail and the female is even red (Fig 2.2).

Standard weight:	Cock	3.8
in kg	Hen	2.9
	Cockerel	3.4
	Pullet	2.5

2.1.1.3 New hampshire

This breed was developed from the Rhode Island Red for early maturity, rapid feathering, large egg size and good quality meat. Some strains were used for broiler production and others for commercial production of brown shelled eggs. The characteristic features of this breed are chestnut-red plumage, single comb and less rectangular body than Rhode Island Red.

Standard weight:	Cock	3.8
in kg	Hen	2.9
	Cockerel	3.4
	Pullet	2.5

2.1.1.4 Wyandotte

Wyandotte is a dual purpose breed with a round and low set body, short back and rose comb. Silver laced, golden-laced, white buff, patridge, silver-pencilled. Columbian and black are some of the varieties of Wyandotte birds.

2.1.2 Asiatic Class

The breeds under this class have feathered shanks, large body with heavy bones and red ear lobes. With the exception of Black Langshan the breeds under this class have yellow skin. They all lay brown shelled eggs. They are classed as broody and poor layers. Brahma, Cochin and Langshan are the three recognized Asiatian breeds which are virtually extinct now.

2.1.2.1 Brahma

Brahma originated in the Brahmaputra Valley in India. Peacomb is the breed characteristic. Light, dark and buff are the most common varieties :

Standard weights in kg :

Light Brahma		Dark Brahma	
Cock	5.4	Cock	4.9
Hen	4.3	Hen	3.6
Cockerel	4.5	Cockerel	4.0
Pullet	3.6	Pullet	3.1

2.1.2.2 Cochin

Cochin is also known as 'Shanghai Fowl' originated in Shanghai, China. They have a single comb and a cushion-like structure, at the base of the tail. The popular varieties are buff, patridge, white and black.

Standard weight in kg	Cock	4.9
	Hen	3.8
	Cockerel	3.6
	Pullet	3.1

2.1.2.3 Langshan

The Langshan breed originated from the Langshan region of China. The principal breed characteristics are short but deeper body than Brahma and Cochin, large tail feathers, tail carried high, long legs, and single comb. Black and White are two main varieties. Black Langshan has dark brown beak, bluish black shanks and toes and pinkish white bottom of the feet. White Langshan has grayish white plumage, slaty-blue or pinkish white beak, slaty-blue shanks and toes with pink between scales.

Standard weight in kg	Cock	3.8
	Hen	3.4
	Cockerel	3.6
	Pullet	2.9

2.1.3 Mediterranean Class

The important Mediterranean breeds of Italian origin include Leghorn, Minorca, Ancona, Spanish and Andalusian. They are light bodied and are developed primarily for egg production. The main characteristics of this class are, white ear lobes, relatively long comb, non broody, early maturity and white-shelled eggs.

2.1.3.1 Leghorn

Among the Mediterranean breeds Leghorn is most popular and is characterized by light body, uniform blending, pretty carriage, long shank, small head with well set rose or single comb and early maturing. Popular varieties are white, brown and black (Fig. 2.3).

Standard weight in kg	Cock	2.6
	Hen	2.0
	Cockerel	2.2
	Pullets	1.8

2.1.3.2 Minorca

Minorca is also known as Red-faced Spanish because of its resemblance to Black Spanish. Single comb black, rose comb black, single comb white, rose comb white and single comb buff are the five varieties. Comb is erect with six evenly and deeply serrated points. Beak is black and shanks and toes are black on dark slaty.

Standard weight in kg	Cock	3.5
	Hen	2.9
	Cockerel	2.9
	Pullets	2.5

2.1.3.3 Ancona

Ancona originated in the vicinity of Ancona in Italy. Single and rose comb are the two varieties.

Standard weight in kg	Cock	3.6
	Hen	2.9
	Cockerel	2.9
	Pullets	2.5

2.1.4 English Class

The breeds of English origin are noted for their excellent fleshing property. With the exception of Cornish all the English breeds have white skin and red ear lobes. English breeds except Dorking and Red cap lay brown shelled eggs.

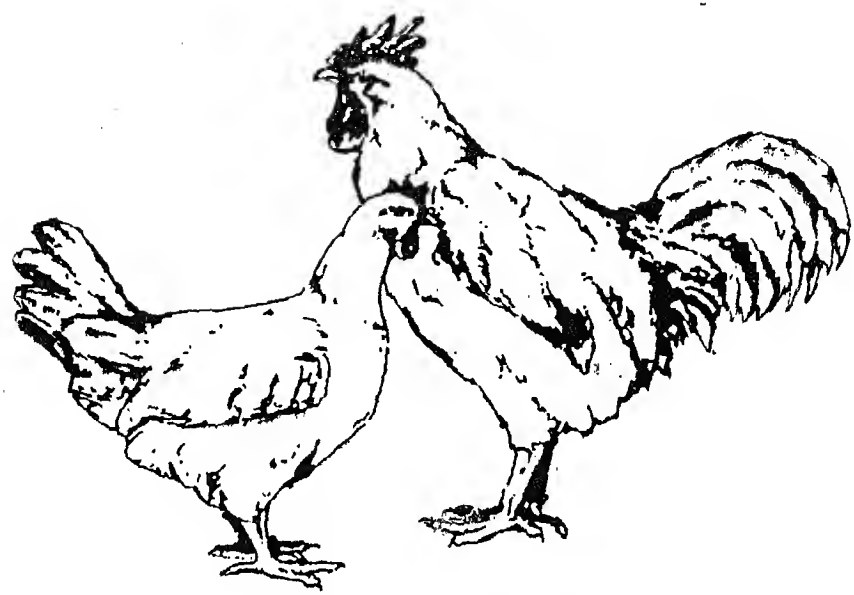


Fig 2.3 Leghorn male and female

2.1.4.1 Orpington

Orpington breed is characterised by its long, deep and well-rounded body with a full breast and a broad back. The body is rather low set and heavy in bones. They have got single comb.

Standard weight:	Cock	4.5
in kg	Hen	3.6
	Cockerel	3.8
	Pullets	3.1

Some of the common varieties of Orpington are Black Orpington, Buff Orpington, White Orpington and Blue Orpington.

2.1.4.2 Cornish

The Cornish fowl is also known as the Indian Game. It appears to have been developed from red Aseel, Old English game and Malay breeds. The breed has been developed for its abundant breast meat. Both the sexes of Cornish are of similar conformation provided by one closely feathered body, very compact body distinctly shaped with heavy flesh. The dark, the white and the white laced red are the three varieties. All Cornish birds have pea comb. Cornish has become very important in development of male lines used for cross-breeding for production of commercial broiler. It is believed that most of the male lines, probably contain 50 % or more Cornish blood.

Standard weights in kg

Dark and White Varieties	: Cock	4.5
	Hen	3.4
	Cockerel	3.6
	Pullet	2.7

White-laced red variety	:	Cock	3.6
		Hen	2.7
		Cockerel	3.1
		Pullet	2.2

2.1.4.3 Australorp

It is an abbreviation of Australian Black Orpington. It has been evolved as a layer bird. It is more upstanding and less massive in appearance than the Black Orpington. The back is long, with a gradual sweep to the tail. The comb is single, beak is black and shanks and toes are black or lead black. The bottom of feet are pinkish white. The plumage is lustrous and greenish-black in all sections.

Standard weight in kg	Cock	3.8
	Hen	2.9
	Cockerel	3.4
	Pullet	2.5

2.1.4.4 Sussex

First developed in England as a table bird. It was developed from birds with four toes. It has a long body, broad shoulders with a good depth from front to rear. It has a well developed breast. These birds have excellent fleshing qualities, single combs and horn coloured beaks, shanks and toes. Speckled, Red and Light Sussex are the three varieties.

Standard weight: in kg	Cock	3.6
	Hen	3.1
	Cockerel	3.4
	Pullet	2.7

2.1.5 Indian Breeds

The common country hen is as a rule the best mother for hatching and is a good forager. Some of the Indian fowls resemble the Leghorn in size and shape but are of poor laying qualities. They are found in various colours. One variety also resembles the Sussex or Plymouth Rock in shape. The Indian birds are mostly non-descriptive and of very little value as layers. There are only four pure breeds of fowls indigenous to India. They are Aseel, Kadaknath, Chittagong and Busra. Some birds, which are believed to have Chittagong, Aseel, Langshan and Brahma blood are in general bigger in size and better in meat quality than the common fowls.

2.1.5.1 Aseel

Aseel is an excellent table bird; with plentiful flesh which is well flavoured. Broodiness is very common and the hen is a good sitter and efficient mother. They are intensely pugnacious and on this account are hard to keep. A few graceful specimens can be found in Andhra Pradesh, Uttar Pradesh and Rajasthan. They possess small and firmly set pea combs. Wattles and ear lobes are bright red. They have a short and slender face with a short beak. The eyes are compact and well set. The neck is long uniformly thick. It has a very close feathered body with a broad breast, straight back and close-set strong tail root. The tail is small and drooping and the legs are strong, straight and set well apart (Fig 2.4). The most popular varieties are Peela (Golden Red), Yakub (Black and Red), Nurie (White), Kagar (Black), Chitta (Black and white spotted), Java (Black), Teekar (Brown) and Reza (light red).

Standard weight in kg	Cock	4.0 to 5.0
	Hen	3.0 to 4.0
	Cockerel	3.5 to 4.5
	Pullet	2.5 to 3.5

2.1.5.2 Kadaknath

Originally this was known as "Kalamasi" meaning a fowl with black flesh, which were bred by tribals in Jhabua and Dhar Districts of Madhya Pradesh. The eggs are light brown. The adult plumage colour varies from silver and gold- spangled to bluish black without any spangling. The skin, the beak, shanks and toes are slate like colour. The comb, wattles and tongue are purple. Most internal organs are black in colour including the blood. It is a small bodied bird, lays moderately. The flesh, although repulsive to look at, is delicious (Fig 2.5). The black pigmentation on various parts is due to the deposition of melanin.

Standard weights: in kg	Cock	1.5
	Hen	1.0

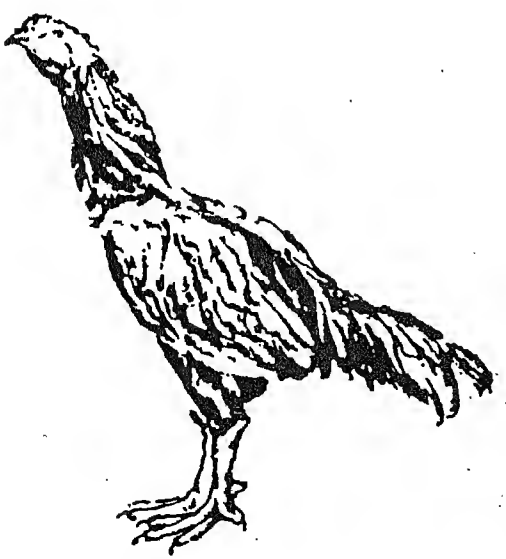


Fig 2.4 Aseel male

2.1.5.3 Chittagong

Chittagong is also known as the Malay. It is found mostly in eastern India. It is a dual purpose breed with poor mothering ability. The adult birds are strong, hardy and quarrelsome. They have a small pea comb. The head is long. The beak is long and yellow in color. The wattles are red and very small in size. The ear lobes are small and red in color. The eyebrows are prominent and overhanging. It has got a deep and broad breast, shoulder is broad with slight narrow loins. The wings project at the shoulders and are carried high. The legs are yellow, the plumage is close to the body and are firm, short and glossy. Some of the common varieties are, buff, white, black, dark brown and grey.

Standard weights: in kg.	Cock	3.5 to 4.5
	Hen	3.0 to 4.0

The important characteristics of classified breeds have been summerised in table 2.1.

2.2 Ducks

It has been accepted since antiquity that domestic ducks were derived from the wild Mallard duck. It is believed that these are descendants from Mallard duck by the presence of curly feathers at the base of the tail in males of the present day duck. Ducks have been bred in a wide range of types and colours. They extend from

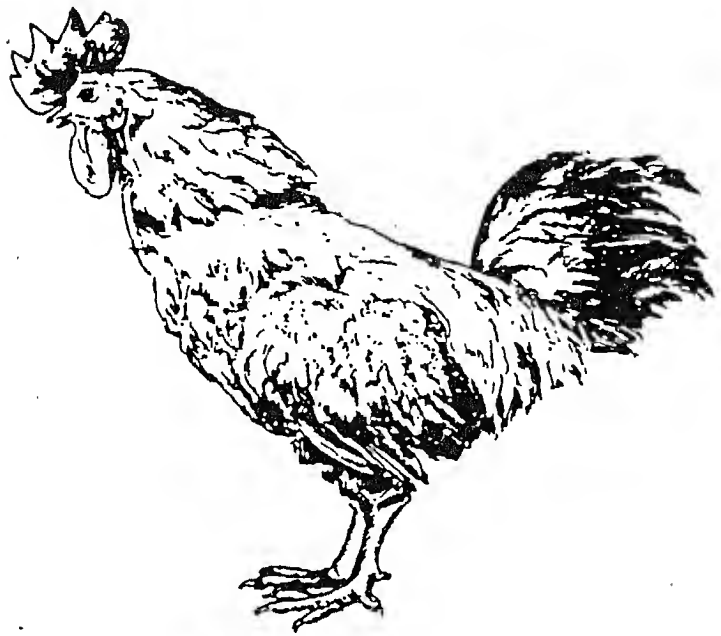


Fig 2.5 Kadaknath male

large heavy weight breeds to miniature type with a large number of intermediate size types. It is therefore convenient to divide these breeds into three categories meat, egg, and ornamental types according to approximate weights and utilities.

2.2.1 Meat Type

The meat type breeds are generally heavy, deep bodied, full breasted and have back of good length. Most important of them are Orpington, Patos, Pekin, Pommeran (2-varieties), Rouen, Aylesbury, Crested and Cayuga.

2.2.1.1 Orpington

There are five varieties of Orpington ducks. It is considered nearer a triple purpose breed. This is particularly true of the buff variety in which certain strains rival the specialized egg breed in prolificacy besides being a very good market duck and an exhibition bird of striking merit. Some of the most common varieties are blue and black Orpington.

Standard weight: Drake 2.2 to 3.3in kg Duck 2.2 to 3.1

2.2.1.2 Pato (Muscovy duck)

This is not a true duck but it closely resembles to the duck family. Under domestication the Pato has proved to be fully as productive as most of the heavier breeds of true ducks. It is an excellent sitter. The males are nearly

TABLE 2.1
Certain Important Characteristics of Classified Breeds of Chicken

Breed	Skin colour	Egg colour	Comb type	Standard weight (kg)		Colour of earlobe	Colour of shank	Shanks feathered
				Cock	Hen			
American								
Plymouth Rock	Yellow	Brown	Single	4.3	3.4	Red	Yellow	No
New Hampshire	Yellow	Brown	Single	3.9	3.0	Red	Yellow	No
Wyandotte	Yellow	Brown	Rose	3.9	3.0	Red	Yellow	No
Rhode Island Red	Yellow	Brown	Single & Rose	3.9	3.0	Red	Yellow	No
Jersey Black Jaint	Yellow	Brown	Single	5.9	4.9	Red	Black	No
English								
Sussex	White	Brown	Single	3.6	3.1	Red	Yellow	No
Australorp	White	Brown	Single	3.9	3.0	Red	Dark Slate	No
Cornish (Dark and White)	Yellow	Brown	Pea	4.5	3.4	Red	Yellow	No
Orphington	White	Brown	Single	4.5	3.6	Red	White	No
Dorking (Silver Grey)	White	White	Single	4.1	3.2	Red	White	No
Mediterranean								
Leghorn	Yellow	White	Single	2.6	2.0	White	Yellow	No
Minorca	White	White	Single	3.5	2.9	White	Yellow	No
Asian								
Brahma	Yellow	Brown	Pea	5.4	4.3	Red	Yellow	No
Cochin	Yellow	Brown	Single	4.0	3.9	Red	Yellow	Yes
Langshan (Black and White)	Yellow	Brown	Single	3.8	3.4	Red	Bluish Black	Yes

twice as heavy as the females.

2.2.1.3 Pekin

Pekin originated from China. The Pekin is not nearly a large white duck but is distinguished by a type exclusively its own. These ducks are quiet consistent with its high fecundity, fertility and rapidity of growth.

Standard weight in kg: Drake 4.0
Duck 3.6

2.2.1.4 Pommeran

The Pommeran has two varieties: the blue and the black; and are native to North East Germany. It is a very active, steady and rapid growing duck of medium size. The Pommeran may be classed as a general purpose breed of a size well suited to an average family table yet with a productiveness that will provide table eggs in generous number. There is a white bib on the

upper breast of the Pommeran varieties.

2.2.1.5 Rouen

Rouen is not well adopted for meat purpose because of its pigmented plumage and less rapid initial growth. At 5 to 6 months of age it becomes as large or often larger than the popular white plumage breeds. It is a French dual purpose breed.

Standard weight in kg: Drake 4.5
Duck 4.0

2.2.2 Egg Type

2.2.2.1 Campbell

The Campbell breed of duck has three varieties: khaki, white and dark. The khaki is the original variety and was named after A. Campbell of England who developed the breed from Mallard blood in addition to strong infusion of Indian Runner blood. It has got a very large body size since some of these reached weight of 1.8 to 2.3 kg in 10-12 weeks of age. The khaki variety still leads the other varieties in popularity because of its established reputation for high production.

Standard weight (kg): Drake 2.2 to 2.4
Duck 2.0 to 2.2

2.2.2.2 Indian runner

The name Indian Runner, indicates its oriental origin. This breed developed a wide range of colour varieties like, white, blue, brown and black. The whites are considered the most prolific layer with an egg yield of 300 or more per year. The angle of inclination of the body to the horizontal varies from 50-80 degrees, when the bird is on the move and not alarmed. But when standing at attention or excited it may assume an almost perpendicular posture.

Standard weight (kg): Drake 1.6 to 2.2
Duck 1.4 to 2.0

2.2.3 Ornamental Type

2.2.3.1 Creasted white

These are small in size but similar in type to Pekins. Crest is large and set firmly on the head, does not drop to any side.

Standard weight (kg): Drake 5.5
Duck 3.0

2.2.4 Indian Breeds

Indian Runner, White Beared, Nageswari and Synthet Meta are the four duck breeds indigenous to India. Most of the indigenous ducks are non descript.

2.3 Turkey

The species from which domestic turkeys descended is the true wild turkey *M. Gallopavo*. The American Poultry Association recognizes seven standard varieties. They are white Holland, Bourbon Red, Narrgansett, Black, Slate, Bronze and Beltsville Small White. Exotic Broad Breasted Bronze, Broad Breasted Large White and Beltsville Small white varieties are more commonly used for commercial purpose. Indigenous and non-descriptive turkeys are found in small numbers in Mirzapur and Allahabad districts of eastern U.P. and in some parts of south India. Matured males are generally heavier than the females. Males of all varieties have conspicuous black beards attached to

the skin of the upper region. Dewbill or Snood, a fleshy protuberance near the base of the beak is relatively large, plump and elastic in males. It is relatively small, thin and non-elastic in females. There are differences in breast feathers also.

Standard weight (kg)

Male	:	4.7 to 15.8
Female	:	2.1 to 6.3

2.4 Guinea Fowl

Guinea fowl belong to order *Galliformes* and family Numididae but some place them in family Phasianidae and subfamily, Numidinae. There are four genera comprising of seven species.

Male are slightly larger than females but otherwise they exhibit no sexual dimorphism. Adult body size ranges from 0.7 to 2.0 kg. The crown of the head carries a bony helmet with a horny sheeth and a pair of wattles hang from the gape. The nares are exposed but in some species inhabiting hot dry areas, the nares are surrounded by warts or cartilaginous bristles. The legs are long and powerful, lacking a spur. Plumage is monotypic. The ground colour is black, with white spots intermeshed with white vermiculation. The spots on the outer margin of secondaries are enlarged to form bars. Some species have a naked neck and rounded red or blue wattles (Fig 2.6).

Three well-known varieties of Indian guinea fowl differentiated on the basis of plumage colour, are the pearl, the white and the lavender.

2.5 Quail

Quail belong to the order Galliformes, family Phasianidae, sub-family Phasianinae, genus Coturnix. Within Coturnix there are five recognized species. These are common quail (*C. coturnix*) comprising of six subspecies; Japanese quail (*C. japonica*); Black Breasted quail (*C. coromandelica*); Marlequin quail (*C. delgorquei*), and Pectoral quail (*C. pectoralis*). The birds of this genus are small, chubby tailless, cinnamon coloured, terrestrial

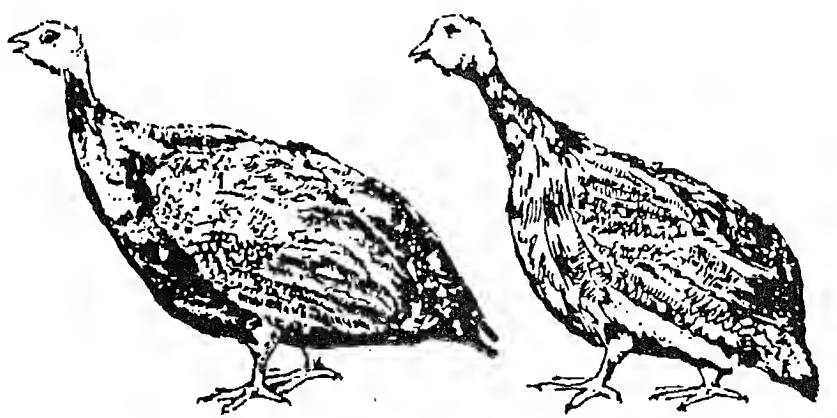


Fig 2.6 Guinea fowl male and female

galli-forms that are extremely variable. The females are heavier (150 to 180 g) than the males (120 to 150 g). The females are characterized by long and pointed feathers with black speckles on the throat and upper breast. The males have rusty brown throat and breast feather. Under favorable environment they produce more than 250 eggs per year. The eggs are multi-coloured ranging from dark brown, blue and white to buff, each mottled with black, brown and blue. Weight of egg is approximately 10 g (Fig 2.7).

2.6 Commercial Hybrids

2.6.1 Egg Layer

Commercial hybrid fowl are synthetic originating in two distinct classes i.e. egg and meat types. Egg producing varieties are white shell and brown shelled egg layers. Their basic characteristics are given in table 2.2.

TABLE 2.2
Basic Characteristics of Commercial Hybrid Layers

Characteristics		White shelled	Brown shelled
(i)	Feather color	White	Brown
(ii)	Ear lobe	White	Brown
(iii)	Adult body weight (kg)	1.6-1.8	1.9-2.1
(iv)	Egg weight (g)	56-60	58-62
(v)	Age at sexual maturity (day)	133	145
(vi)	Colour of egg shell	White	Brown
(vii)	Egg production up to 72 weeks	270-290	260-280

Many commercial trade varieties are available in India which are exotic and indigenous in origin. Few are listed in table 2.3.

2.6.2 Broilers

Commercial broilers are marketed between 5-7 weeks of age. Cornish, Plymouth Rock, Light sussex and New

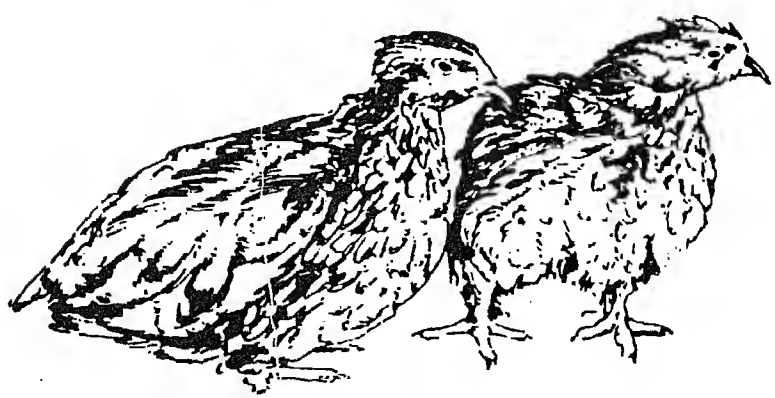


Fig 2.7 Quail male and female

TABLE 2.3
A Few Commercial Hybrid Layers

Indian Hybrids	Exotic Hybrid	
1. ILI-80 Indian Layer. Izatnagar	Dekalb	D.J.Group Bangalore
2. ILM-90 Indian Layer. Mannuthy	H and N	Tarkeshwara Hatcheries Nasik.
3. HH-260 Indian Layer. Bangalore	BV-300	Venkateshwara Hatcheries, Pvt. Ltd Poona
4. BH-78 Indian Layer. Mumbai	LSR	Kasila Farm, Hyderabad
5. Key-stone New Delhi		
6. Jawahar-260 Jabalpur	Bovans	Bovans Poultry LTD Hyderabad

Hampshire, etc. pure breeds were utilized to develop modern commercial synthetic broiler chicks. The few common trade names of commercials are given in table 2.4.

TABLE 2.4
A few Commercial Broilers

Indian commercial	Exotic commercial	
IBI (Indian Broiler, Izatnagar)	Hypeco	Bovans Breeding Farm, Hyderabad
IBB (Indian Broiler, Bangalore)	Ven-Cobb	Venkateshwara Hatcheries Poona
IBL (Indian Broiler, Ludhiana)	Hubbard	Kasila Farm, Hyderabad
V-Broiler, Jabalpur, Kegbro, Delhi	Ross	D.J.Group, Bangalore
	Anak-2000	Tarkeshwara Hatcheries Nasik
	Star-Bro	Basic Breeders, Hyderabad

On an average commercial broiler chick raised by farmers attain 1.5 kg weight with 3.4 kg feed consumption with 3.5% mortality up to 6-weeks of age.

2.7 Franchise Hatcheries

Essentially franchise hatcheries are responsible to supply chicks to the poultry farmers and are in their direct contact through their agents. They purchase parent stock chicks usually from secondary breeders and simply raise these parents at maturity and in a specified ratio of males and females to produce commercial day old chicks. Hatcheries follow instructions of management, feeding, disease control as received from secondary breeders who house grand parents stocks. As such many franchise hatcheries will be receiving parents from the same source. The management, bio-security and hygienic conditions will also influence quality of chicks and their subsequent performance. In short, function/responsibilities of franchise hatcheries are given here.

1. Contract with grandparent/pure line breeder who house reputed stocks and have strong research and development wing.
2. Strict bio-security arrangements to control spread of infections which are transmitted through egg, hatchery machines and persons working.
3. Maintain nutritional feeding norms so that quality chicks are supplied to farmers.
4. In case of layer hatchery accurate sexing arrangements be made so that farmer may get minimum number of male chicks.. They

should provide service facilities to farmers.

5. Increase awareness of new technology and knowledge through publication, seminars, discussion and meeting.

2.8 The Organised Poultry Research and Development

The organised poultry research and development in India is divided into public and private sectors as illustrated in fig. 2.8.

During the Fourth Five Year Plan period, the Indian Council of Agricultural Research launched two All India Coordinated Research Projects (for development of egg layer and commercial broiler) at ICAR Institutes and various agricultural universities. Project Directorate in Poultry was established in the VII Plan. During the Second Five Year Plan four regional poultry breeding farms were established by Ministry of Agriculture, Government of India. State government poultry farms and agricultural universities are strong components for extension, research and training in poultry production.

In the last 20 years private sector has emerged as a force through their research and development effort towards poultry production, research and training by establishing many institutes, breeding farms and vaccine production unit etc.

2.9 Breeding Companies

Some of the important foreign companies of poultry are listed below whose collaborators are in India.

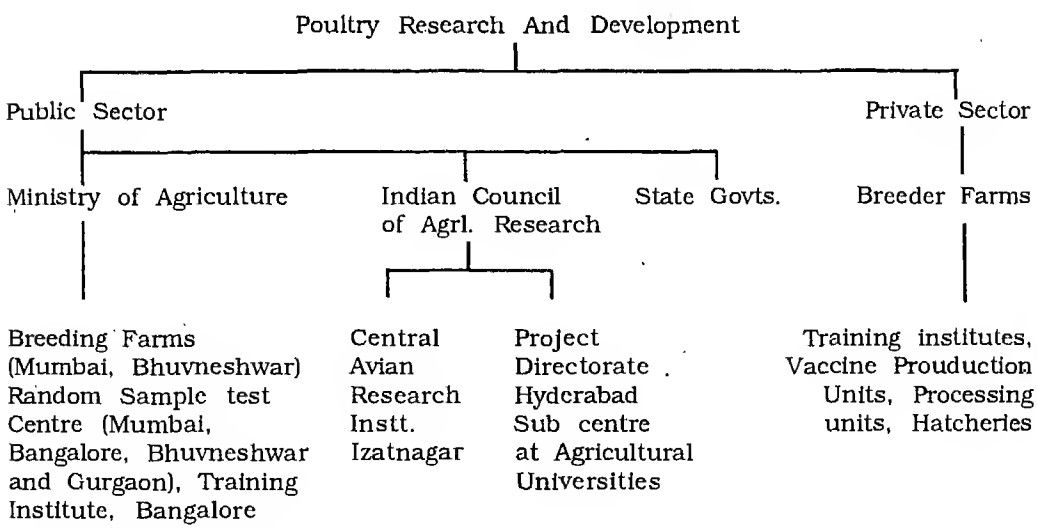


Fig. 2.8 Schematic chart of organised poultry research and development

Foreign company	Indian counterpart
Poultry	
Shaver Breeding Farm, Canada	Basic Breeders Ltd, Hyderabad
Dekalb Agricultural, U.S.A,	D.J.Hatcharies Pvt.Ltd, Bangalore
Research Incorporate Hubbard, U.S.A	Kasila Farm, Hydera bad
Lohman, West Germany	Kasila Farms, Hyderabad
Poultry Breeders, Israel Union	Tarkeshwara Hatcheries, Nasik
Euribrid Henderex,	Bovans Breeding
Holland and others	Farm Pvt. Ltd., Hyderabad
Ducks	
Cherry Valley	-
Farm Ltd, England	
Duck Breeding Farm	Bangalore

QUESTIONS

1. Give in brief various classification of chicken breeds.
2. Name two dual purpose breeds of chicken with their breed characteristics.
3. Tick the correct answer (√).
   (a) White Leghorn is a meat breed of chicken. T/F
   (b) R.I.R. is a dual purpose breed. T/F
   (c) Standard weight of White Plymouth Rock male is about 4 kg. T/F
   (d) Asian class of chicken breed has red ear lobe. T/F
   (e) Cornish breed of chicken belongs to English class. T/F
4. Name two breeds of ducks and turkey, commercial hybrid layer and broilers.
5. Write short notes on guinea fowls and quails.

CHAPTER 3

Body Parts of Chicken

3.1 Identification of Body Parts

The terms as applicable to different body parts of chicken (Fig 3.1 and 3.2) are given below:

Comb, Nostril, Upper mandible, Lower mandible, Beak, Throat, Wattle, Hackle, Skull, Eye, Ear, Face, Earlobe, Front of neck or Plumage, Cape, Shoulder, Wing front, Wing bow, Wing coverts or Wing bars, Breast, Secondaries or Wing bay, Primary coverts, Primaries, Abdomen, Spur, Toes, Claw, Shank, Hock joint, Hock plumage, Fluff or Stern, Lower thigh feathers, Rear body feathers, Lower

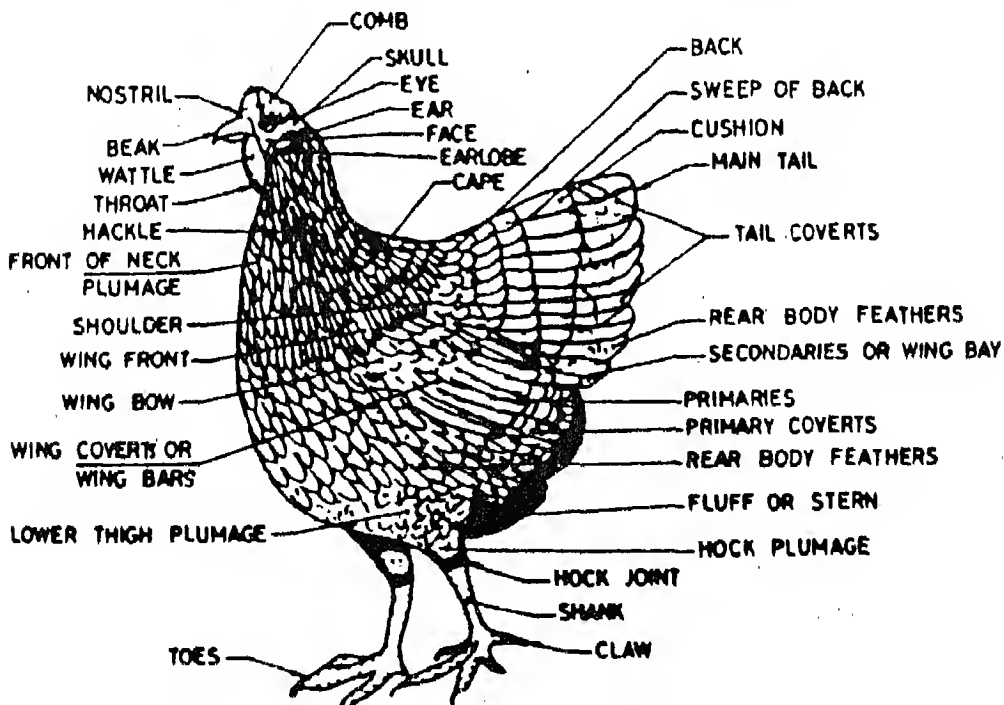


Fig 3.1 Body parts of female chicken

saddle, Main sickles, Main tail, Lesser sickles, Tail coverts, Upper saddle, sweep of back, Cushion and Back.

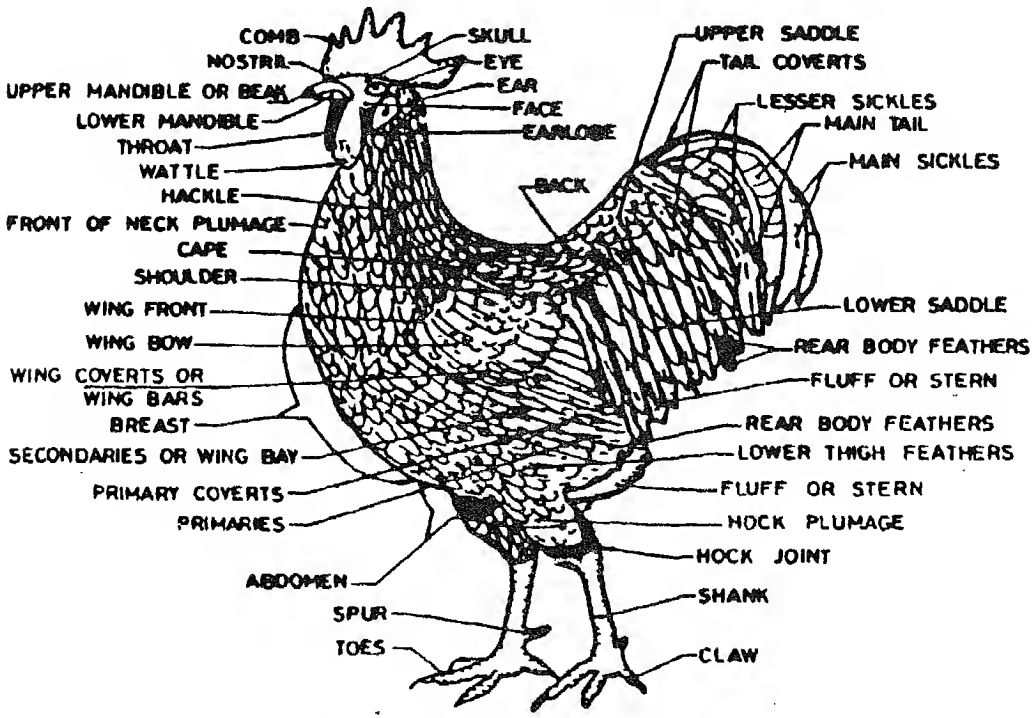


Fig 3.2 Body parts of male chicken

QUESTIONS

1. Make a suitable diagram of chicken depicting different parts of the body.
2. Tick the correct answer (✓)
   (a) White leghorn has a single comb. T/F
   (b) Aseel has pea comb. T/F
   (c) Main tail feathers are large upright in male chicken. T/F
   (d) Spur is found on the shank of female chicken. T/F
   (e) White leghorn has a red ear lobe. T/F

CHAPTER 4

Laws of Inheritance

The first quantitative study of inheritance was carried out by Gregor Mendel in garden peas and published first in 1866.

4.1 Mendel's Experiment

Mendel first identified characters, which had two different contrasting forms of a particular character. He then ensured that, they are breeding true. For example colour of flower may be either purple or white and seeds of purple- flowered plant produced only purpled-flowered plants and so on.

The second stage was to hybridize or cross-pollinate plants with alternate form of a trait. For example, he hybridized purple and white flowered varieties and so on. Such a cross where two forms of single trait are brought together or hybridized is called a monohybrid cross. The hybrid offspring constitutes the next generation and is termed first filial generation or F_1-generation.

In the third stage he allowed each hybrid offspring plant to self pollinate and produce the second filial generation or F_2 generation and recorded each type of contrasting forms.

4.1.1 Mendel's Findings

(i) F_1-resembles only one parent. He noted that, the hybrid offspring (F_1) invariably resembled one parent and not the other. This was true for reciprocal crosses as well.

(ii) F_2 generation (selfing of F_1)- Dominant and recessive forms appear in a 3:1 ratio. In F_2 both parental forms reappeared. Mendel termed the form of the trait expressed in F_1 as dominant and other which has hidden as recessive. This ratio of 3:1 is now generally termed as the Mendelian ratio or monohybrid ratio.

Mendel's observations may be summarized as

i. F_1 hybrids always exhibited only one of the parental forms of a trait.
ii. Both parental forms are expressed in F_2.
iii. The form of the trait that appeared in F_1 (dominant form), appeared in F_2 generation about three times as frequent as its alternate form (recessive form).

The results of Mendel's experiment showed that, the observed monohybrid ratio of 3:1 of dominant to recessive forms of a trait in the F_2 generation was in reality a hidden 1:2:1 ratio of

¼ pure dominant, ½ impure of hybrid dominant and ¼ pure recessive.

Using symbol 'A' and 'a' for the dominant and recessive forms, respectively for any hypothetical trait, we can show how the 1:2:1 ratio can be obtained from the rationale depicted in fig. 4.1. A monohybrid cross between pure dominant and pure recessive varieties for any hypothetical trait traced through two generations. The F_2-genotypes are in 1:2:1 ratio.

4.1.2 Dominance

Mendel observed that, one of the parental forms of a trait was always absent in the F_1-hybrid but reappeared unchanged in F_2-generation. Mendel therefore, concluded that what were transmitted from parent to offspring were discreet factors and each factor contained information about the form of the trait. The factors associated with the form which was expressed in hybrid offspring (F_1) was dominant. The factor associated with the form which remained hidden in the F_1 but reappeared in F_2 was recessive. Mendel's factor is now recognized as the gene.

4.1.3 Principle of Segregation

The essential point to understand here is the separation or segregation of the two factors (genes) during the formation of male and female gametes. In the hybrid plant (F_1) these are the dominant and recessive forms of the factor. Consequently, two types of male or female gamets, A or a are formed in equal (50% to 50%) proportions. Once separated the factors are randomly united in pairs during fertilization and transferred to the progeny. In the pure form individuals (true breeding), both factors, are alike. So only one type of gamet is formed bearing either a dominant or recessive factor. This is referred to as *Mendel's principle of segregation* .

Symbols are assigned to the alleles of the genes determining a genetic trait. Genetic traits were usually assigned a letter symbol referring to their dominant state. Thus for example, rose comb pattern is dominant over single comb pattern in poultry. So the dominant allele (Rose comb) is symbolised by capital 'R' and recessive allel (Single comb) with small 'r'.

4.1.4 Principle of Independent Assortment

After observing the principle of segregation, Mendel tried to find answers to the following questions. Do different genes which are responsible for different traits also separate or segregate independently of each other? How would the alleles of two different genes affect each other during their inheritance?

Mendel followed the same three stages of experimentation as he did for monohybrid cross to answer these questions. First he established true breeding pea lines that differed from one another in two of the traits.

His second step was to hybridize contrasting pairs for the two traits in the true breeding lines. Such a cross is called dihybrid cross. For example he crossed double dominant round and yellow seed pea plant (RRYY) with the

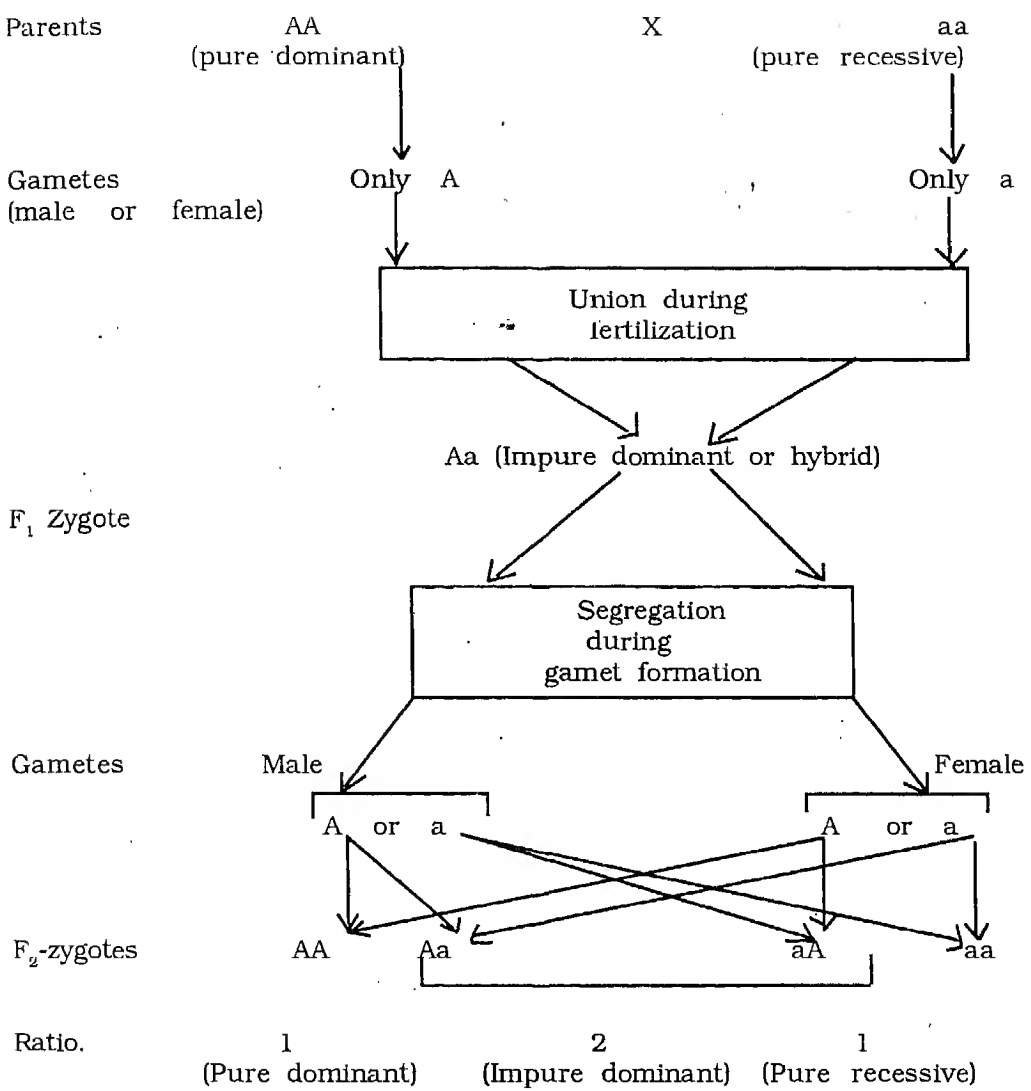


FIG 4.1: A monohybrid cross between pure dominant and pure recessive varieties for any hypothetical trait traced through two generations. The F_2 genotypes are in 1:2:1 ratio.

double recessive wrinkle and green seeded pea plant (rryy).

The F_1 offsprings of the dihybrid cross were all round and yellow seeded. This showed that the dominant allele for the two genes expressed themselves in the same way when together as they had when they were separate in the monohybrid crosses. Apparently the presence of one of the genes did not influence the effect of the other.

In the third step, Mendel self pollinated the F_1 - offsprings and raised the F_2- generation. In the F_2 he found both the parental combinations, round and yellow seeds and wrinkle and green seeds.

In addition he found two new combinations; round and green seeds and wrinkle and yellow seeds. These are called recombinant. A ratio of 9:3:3:1 is therefore predicted for the four possible phenotypes, round yellow, round green, wrinkle yellow and wrinkled green. As each gene has two alleles, we can conclude that each allele pair assorts independently of the other during gamet formation.

These observations of Mendel are often referred to as the *principle of independent assortment.*

4.1.5 Basic Terms Used in Inheritance Studies

Scientific study of heredity is called Genetics. Central to this study is the Gene, a unit of heredity. It is essentially a unit of information. The various forms of a gene are called alleles. So the dominant and recessive factors of Mendel are alleles of a gene. Genes occur in pairs on homologous chromosome, one of each pair comes from each of the parents. When genes affecting the same character in different manners, occur together on identical locations on each member of a pair of homologous chromosomes as in an Aa hybrid, the individual is said to be heterozygous. If identical genes occupy two homologous chromosomes, as in AA or aa, - the individual is said to be homozygous. The genotype is the genetic makeup of an individual. (AA, Aa, aa are the genotypes of an individual with reference to these particular pair of allele). The 1:2:1 is the genotypic ratio. The expression of genotype is called phenotype. The same dominant phenotype can result from two genotypes, homozygous dominant (AA) or heterozygous dominant (Aa). The 3:1 monohybrid ratio is phenotypic ratio. Using symbol A, a and B, b for dominant and recessive forms, respectively for any two hypothetical traits, it can be shown how the 9:3:3:1 ratio can be obtained using the above arguments (Fig.4.2).

4.2 Inheritance of Morphological Traits

4.2.1 Inheritance of Comb Pattern

The type of comb, for example, rose comb, pea comb, single comb and walnut comb is a trait that is inherited in a relatively easily understood fashion.

Rose comb is denoted by 'R' because it is dominant over single comb which is denoted by 'r'. Crossing of rose comb birds with single comb birds show that rose is dominant over single on a monohybrid basis. The

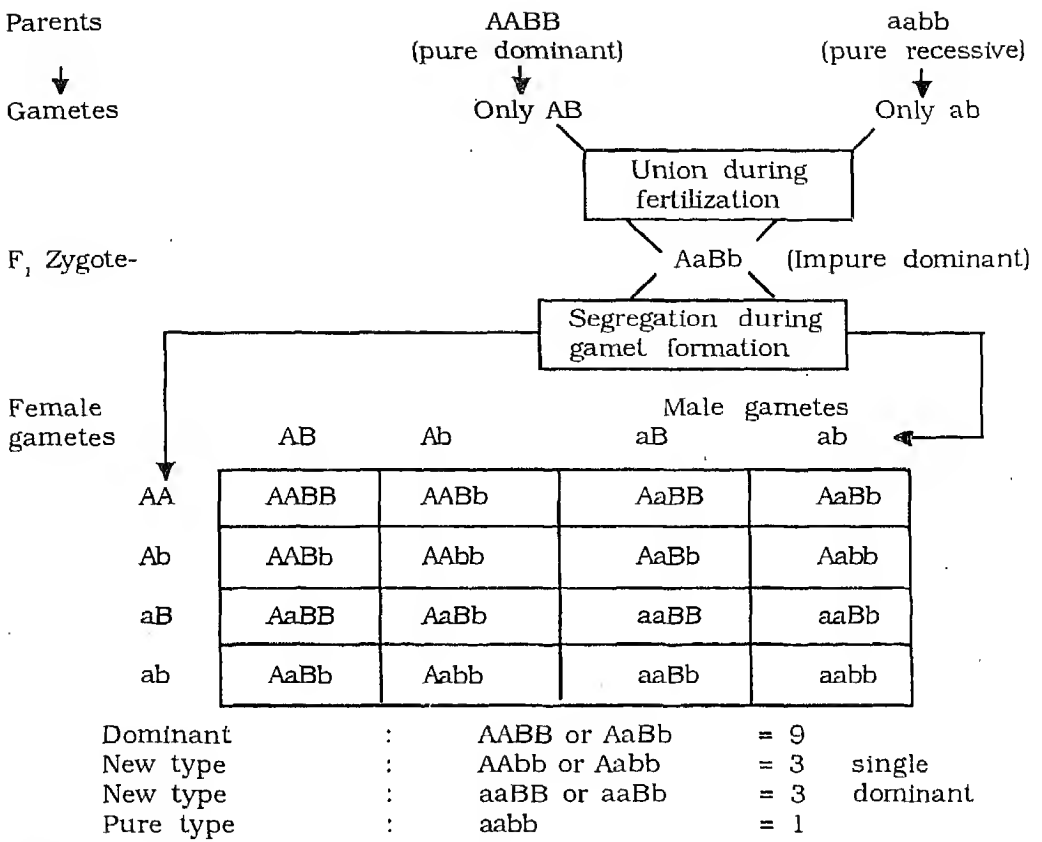
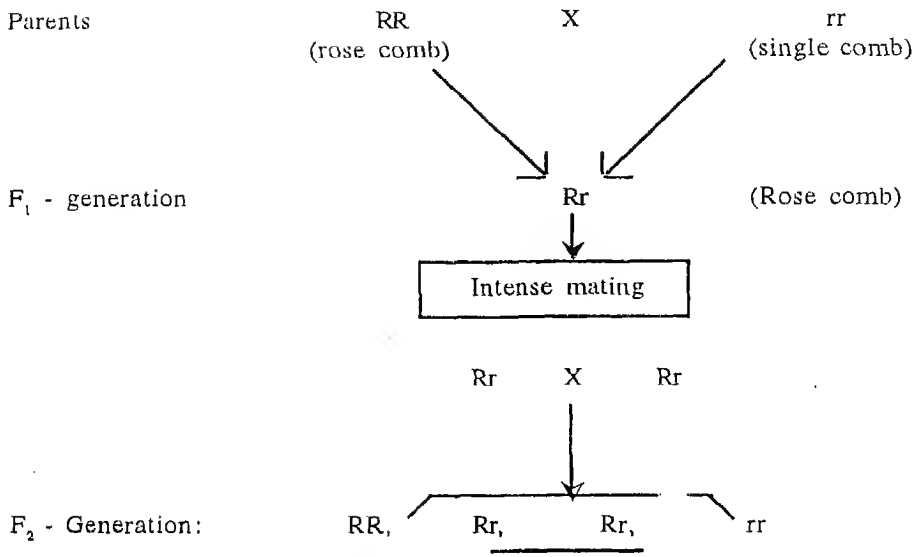


Fig. 4.2 A dihybrid cross between pure dominant and pure recessive varieties for any hypothetical trait traced through two generations. The F_2 phenotypes are in the Mendelian dihybrid ratio of 9:3:3:1.

F_2 generation segregate in the proportion of 3-rose to 1-single. The genotypes of rosecomb birds can be RR or Rr (Fig.4.3).

Pea comb, the gene for which is designated as 'P' is less completely dominant to single comb than the rose comb gene (R). In heterozygote form the dominance of 'P' is only partial and the shape of comb is not exactly similar to the one that is observed when it is in pure dominant form. The genotypes of the pea comb birds will be PP or Pp.

When a rose comb and a pea comb bird are mated together, each has a recessive allelomorph of the other, so that the rose comb birds would be RRpp and a pea comb bird would be rrPP, the F_1 birds would be RrPp which is the walnut type of comb. When the F_1 birds having walnut combs are



RR - Pure rose comb
Rr - Impure rose comb
rr - Single comb

Fig. 4.3 A monohybrid cross between pure rose comb bird with pure single comb bird traced through two generations showing dominance of rose comb over single comb.

mated among themselves, both the males and females produce four kinds of gametes; that are, RP, Rp, rP, and rp. The mating of these four kinds of F_1-gametes produces a F_2 ratio of 9:3:3:1. The F_2 ratio consists of 9 birds of walnut comb, 3 birds of rose comb, 3-birds of pea comb and 1-bird of single comb type. The walnut type of comb, is the result of the interaction of the genes R and P and the combination of recessive allelomorphs rr and pp, produces single comb type (Fig. 4.4).

4.2.2 Inheritance of Plumage Colour

Colour of plumage in domestic fowl are among the most conspicuous of all the characters they possess and it constitutes the basis for differentiating the varieties of a breed. The colour of feather is determined by the genetic constitutions of the cells.

4.2.2.1 Black colour

In some breeds only black colour is recognized such as Austrolorp. The symbol generally used to designate the presence of black pigment of any kind is 'C' (colour), but birds with solid black pigment must also carry a gene 'E' which permits extension of colours to all parts of plumage. Black is recessive to the white of the White leghorns but dominant to the white in all recessive white breeds and varieties.

4.2.2.2 White colour

Generally there are two kinds of white plumage. One is dominant white and the other is recessive white. In addition there is a Columbian pattern plumage which is mostly white with some black feathers. White colour has become the favourite colour in all segments of poultry industry. The White Leghorn are preferred for egg production and the White Rock are preferred as male line for broiler production.

4.2.2.2.1 Dominant white: White Leghorn typically represents this kind of white plumage. It is determined by a gene 'I' (Inhibitor gene), which prevents the production of melamin pigment, thereby prevents the possibility of any colour on the plumage. Because of the 'I' gene the Leghorns are white in plumage inspite of having genes for colour (C) and

Parent RRpp (Rose comb) × rrPP (Pea comb)

F_1 generation RrPp Walnut comb

F_2 generation	Male gametes RP	Rp	rP	rp
Female gametes RP	RRPP walnut	RRPp walnut	RrPP walnut	RrPp walnut
Rp	RRPp walnut	RRpp rose	RrPp walnut	Rrpp rose
rP	RrPP walnut	RrPp walnut	rrPP pea	rrPp pea
rp	RrPp walnut	Rrpp rose	rrPp pea	rrpp single

Phenotype ratio :

Walnut	9
Rose	3
Pea	3
Single	1

Fig. 4.4 A cross between rose and single comb bird each having recessive allelomorph

barring (B), which they are unable to express.

The resulting progenies in F_2 are white in colour but the progenies carrying 'II' combinations are predominantly white with varying amount of black and the 'II' combinations are pure white in colour. This shows that 'I' is incompletely dominant to black colour. 'I' gene is also incompletely dominant to red or buff colour.

4.2.2.2.2 Recessive white : Except White Leghorn, in other white breeds white is recessive to colour. This recessive white plumage is determined by a pair of 'cc' genes. Cross of these recessive white birds (cc) with the coloured varieties (CC) yield coloured progeny. The 'c' is completely recessive to black plumage. The dominant white and recessive white look identical in adult birds. They can be differentiated by breeding test.

4.2.2.3 Blue colour

Blue is a breed characteristic in Blue-Andalusians and a varietal colour in Orpington and Plymouth Rock. When blue birds are mated together they produce black, blue and blue splashed white progeny in the ratio of 1:2:1. This suggests that, blue is heterozygous for gene 'blue'. When homozygous blue, it makes the birds predominantly white except for a few blue feathers. Blue gene is considered here as a incomplete dominant character.

4.3 Quantitative Inheritance

All the traits studied by Mendel were either/ or type. The seeds were either round or wrinkle, tall or short and so on. There were no intermediates. However several traits show a series of different types. Human skin colour can be graded from black to white with all intermediate shades. Similarly in poultry weight of birds or number of eggs a bird lays show various grades. Though heredity and environment contribute to the production of graded phenotypes, continuous variation is often due to additive effects of two or more genes of the traits. Such traits are polygenic traits and show continuous variation. The frequency distribution of such characters can be fitted as a bell shaped curve. Variation of this sort without natural discontinuties is called continuous variation and the characters that exhibit it are called quantitative characters or metric characters, because their study depends on measurement. Such inheritance is called quantitative inheritance.

Expression of traits of economic importance are governed by many pairs of genes. Each pair contributes its little effect but is difficult to measure it independently, therefore, is termed as polygenic inheritance. Egg production, egg weight, body weight are example of quantitative or polygenically controlled economically measurable traits. Population 'N is an aggregate of individuals and each have 2n genes thus the population would have 2n genes. This is referred as gene pool.

4.3.1 Genetic Relationship

The information on cumulative effect of genes/gene pool on a particular

characters is required by breeders. The relationship is measured from male and female parents as each contributes ½ the genetic material to its progeny. The relationship among group of full-sib and half-sib is explained in Fig 4.6.

The figure shows that the genetic relationship among groups of full sib progeny is ½ whereas half sib relationship is ¼. The measurement of traits show variation among full-sib or half-sib produced from many parents simultaneously. Therefore, the dispersion among measurements among half-sib, full-sib and other relatives is interpreted in terms of variances (σ^2). The variance thus may be phenotypic i.e. what we measure and genetic i.e. what fraction progeny inherits from parents. These are termed phenotypic variance (σ_p^2) and genetic variance (σ_G^2).

4.3.2 *Component of Variance*

The phonotype of an individual is the sum of genetic (G), environmental (E) and the interaction between genotype x environment (GxE). The genetic variance has additive (A), dominance (D) and epistatic (I) components as per the nature of geneaction exerting influence on quantitative traits. This relationship is illustrated below:

Phenotype → Genotype(G)
- Additive AA, V_A or σ_A^2
- (GxE) Dominance DD, V_D or σ_D^2
- Environment (E)
- Epistasis I, V_I or σ_I^2

Thus simply the equation of the phenotype of individual character can be written as under

Phenotype of character P = G+E+GXE

or interms of variances = A+D+I+E+GXE

$$\sigma_p^2 = \sigma_G^2 + \sigma_E^2 + \sigma_{GE}^2$$
$$= \sigma_A^2 + \sigma_D^2 + \sigma_I^2 + \sigma_E^2 + \sigma_{GE}^2$$

The gentic relationship among some of the relatives is given in table 4.1 and fig. 4.6.

TABLE 4.1
Genetic Relationship Among Relatives

Relationship	V_A	V_D	V_{AA}	V_{DD}
Offspring and one parent	½	-	¼	-
Half sib	¼	¼	¼	1/16
Full sib	½	¼	¼	1/16

4.3.3 *Heritability*

In poultry breeding relation-ship is expressed as a ratio of genetic variances to the total phenotypic variance and is termed as heritability. Therefore, the heritability (h^2) is that fraction of variance which is probably inherited by progeny from its parents. Heritability is defined in narrow and broad sense.

A. Heritability (narrow sense) $h^2 = \dfrac{V_A}{V_A+V_D+V_I+V_E+V_{GE}} = \dfrac{\sigma_A^2}{\sigma_P^2}$

B. Heritability (broad sense) $h^2 = \dfrac{V_A+V_D+V_I}{V_A+V_D+V_I+V_E+V_{GE}} = \dfrac{\sigma_A^2}{\sigma_P^2}$

A Cross between Dominant White and Coloured Bird Showing the Effect of Gene 'I' which Inhibits the Development of Colour.

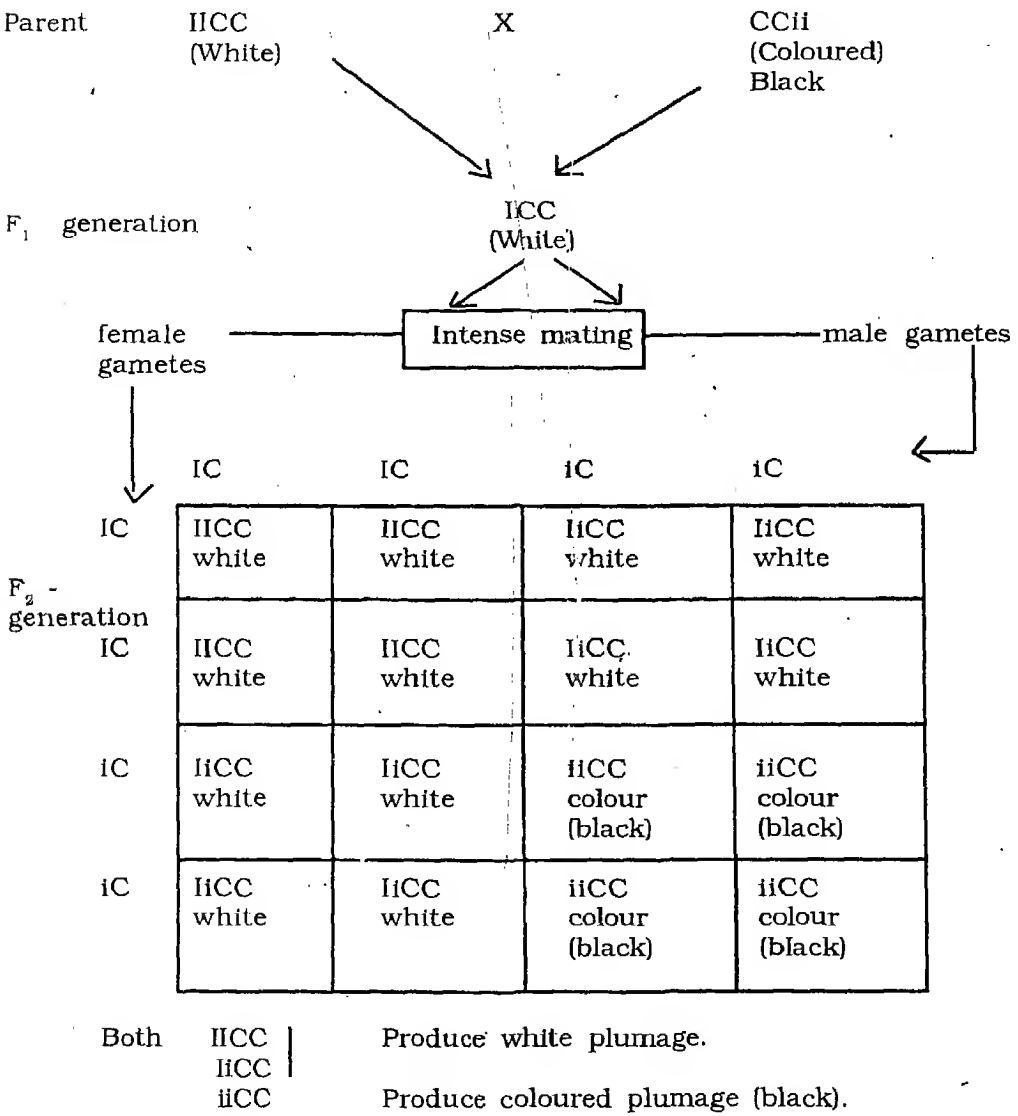


Fig. 4.5. A cross between dominant white and coloured bird

The value of heritability by method 'A' is smaller to the method B. However the probability of transfer of heritable fraction due to additive genetic variance σ_A^2/σ_P^2 from parent to progeny is more.

The breeding value is another term used in poultry breeding which is the deviation of average performance of offspring from that of the population mean.

Breeding value of individual = 2 x (Progeny mean - Population mean)

The breeding value is also referred as additive genotype and difference in breeding value is termed as additive effect which is the heritable portion.

The characterstic whose heritability is more can be improved rapidly than those where heritability is low. In poultry, body weight, egg weight are classified as highly heritable traits whereas fertility, hatchability and egg production are lowly heritable traits and age at Ist egg laid has medium heritability.

4.3.4 Genetic Correlations

A gene affects the expression of a trait but it may also influence the expression of other traits. This peculiarity of gene is termed as pleiotropy which is the major cause of relationship between two traits of an individual or its relatives. The genes affecting egg production also influence egg size. Thus ratio of genetic covariance with variance of the two traits is termed as genetic correlation. The corralations could be phenotypic, genetic and environmental.

$$\text{Genetic Correlation (rg)} = \frac{\text{Genetic Covariance between X and Y}}{\sqrt{\sigma_G^2 \text{ of trait X} \; \sigma_G^2 \text{ of trait Y}}}$$

$$= \frac{\text{Cov}_G\,(XY)}{\sqrt{\sigma_G^2\,(X)\;\sigma_G^2\,(Y)}}$$

In selection for a particular trait X for improvement, there is likelyhood of change in trait Y which is called correlated response.

Heritabilities and genetic correlation values for some of the important economic traits in poultry are given in table 4.2.

4.3.5 Disease Resistance

It is well evident that, breeds and different strains in the same breed differ in their inherent ability to resist a specific disease or abnormal condition. Immunity from disease is a hereditary character and can be improved by appropriate breeding. Resistance to diseases is inherited and in all probability in Mendelian manner where resistance was observed to be dominant over susceptibility. However, the degree of resistance varies with the prevailing physical and physiological conditions. So it is apparent that the inheritance of susceptibility to an infectious agent is fairly complex. Hence hereditary basis of resistance or susceptibility is not as simple as it is observed but probably depends upon multiple genes. But for understanding it can be explained on the basis of single gene

TABLE 4.2
Heritability and Correlation Among Traits

	Egg production	Age at maturity	Egg weight	Body weight
Egg production	.20	.74	.21	.19
Age at maturity	-.42	.29	.24	.27
Egg weight	-.15	.06	.36	.40
Body weight	-.01	.05	.25	.45

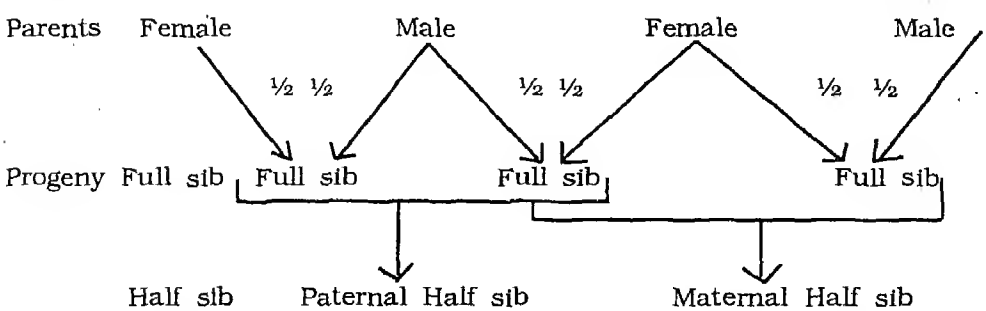
Note: Mid values are heritabilities which are underlined, upper values genetic correlations and lower values are phenotypic correlations.

effect where resistance (RR) is dominant over susceptibility (rr).

4.4 Chromosomes and Genes

4.4.1 *Autosomal and Sex-linked Chromosomes*

Chromosomes usually occur in pairs and their number varies from species to species. Chicken have 39-pairs, Japanese quails 39 pairs and Turkey 41-pairs. Out of the 39-pairs of chromosomes in chicken, 38 pairs are autosomes and one pair is sex chromosome. In avian species sex chromosomes are designated as Z and W corresponding to X and Y chromosomes in mammals. The males have a pair of ZZ sex chromosomes and are called homogametic sex because they produce only one kind of gamet, that is both bearing Z and Z; where as the females have a pair of ZW sex-chromosomes and are called heterogametic sex because they produce two kinds of gametes, that is one bearing Z and the other bearing W. In most avian species there are two distinct size groups of chromosomes. Five or six pairs out of 39-pairs are



Relationship among = Full sib = (½ x ½) + (½ x ½) = ½
Half sib = (½ x ½) = ¼

Fig. 4.6 Relationship among relatives

large chromosomes called as macro-chromosomes. Others are small without any distinguishing features and known as micro-chromosomes.

The exact role of micro-chromosomes in the inheritance is not known. 'Z'-chromosome in chicken is very important because, it is the fifth largest and comprises 10% of the total avian genome. Of the 6-known linkage groups, the best known is the sex-linkage groups. At least 16 - different segregating loci have been identified in the sex-linked group. The 'W'-chromosome does not seems to carry much genetic information.

4.4.2 Sex-Linked Genes

Sex-linked genes are the genes which are present in the sex-chromosome. Many characters are inherited equally from sire and dam. The genes giving rise to such characters are located on autosomes. But certain characters are transmitted by the dams only to its sons but not to the daughters because the 'W' chromosome which it gives to its daughters do not have a corresponding gene in it. The sire on the other hand transmits any character which it possess to its son and daughter alike. As explained earlier, in birds the male is homogametic, that is it carries a full complement of paired chromosomes (ZZ). The female is heterogametic and carries a substitute and dissimilar 'W' chromosome, thus not making a proper chromosome pair (ZW). The chromosomes concerned are known as sex-chromosomes and the gamet of heterogametic sex determine whether offspring are to be male or female. Therefore, characters that are transmitted from dams to their male progeny only are called sex-linked character, because, the genes that determine such character are born on the sex-chromosome. Thus another way of looking at sex-linkage is that a dam makes little or no sex-chromosome contribution to her daughters (Fig.4.7). It is believed that the 'W'-chromosome in females does not carry any gene and so the males are always referred as 'ZZ' and the females as 'Z'.

4.5 Sexing Methods

An interesting feature of inheritance of several sex-linked characters is that some of them help in distinguishing the sex of chicks at the time of hatching. If a female carries a sex-linked recessive gene, then female parent will contribute to the male progeny. Thus the males will show the dominant character and female progeny will be recessive. So the males can be identified at the time of hatching which is of much importance in commercial sexing procedures. This is possible in the inheritance of characters which are sex-linked such as silver and gold pair of characters, the slow and rapid feathering pair of characters and barred and unbarred pair of characters. Another most common method of sexing is Japanese or vent method of sexing, where the males are identified by observing the presence of rudimentary papilae in the cloaca.

4.5.1 Feather Sexing

In some breeds, notably those of Mediterranean origin, the chicks

feather more rapidly than the others. The characteristic is due to the presence of sex-linked recessive gene (k) which is responsible for rapid growth of the primary wing and tail feathers in those chicks hemizygous or homozygous for the gene. Where rapid feathering males (kk) that is Leghorns and New Hampshires, are crossed with slow feathering females (K-) that is Rhode Island Red and Light Sussex, all the female offsprings will be rapid feathering (Fig.4.8). Female chicks of this cross will, at day-old, usually show the primary feathers of the wing clearly pushing their way out. Emerging tail feathers should also be observed. In male chicks the primary wing and tail feathers will, by comparison, be underdeveloped. In the chicks to differentiate the sex according to fast and slow feathering three methods are employed.

i. Length of primary wing feather, and the relative length of coverts.
ii. The number of secondary wing feather at hatching time.
iii. The relative length of tail feathers at about 10-days of age.

Characteristics of fast and slow feathering chicks are given in table 4.3.

4.5.2 *Colour Sexing*

4.5.2.1 *Barred-unbarred pair of characters*

When an unbarred male is mated with a barred female, only the male progeny are barred (Fig.4.9). This suggests that the gene for barring (B) which produces the barring effect on each feather is located on the sex-chromosome.

This gene restricts the black pigment on plumage to bars. The white bars which alternate with the black ones are due to the presence of gene due to silver (S) which is also sex-linked. The gene for barring apparently has a cumulative effect because of which, the white bars in the males are found to be approximately twice as wide as black bars. This is because of effect of two barring genes in males as opposed to the one barring gene observed in females. The down has a different expression corresponding to barred unbarred condition. Barred black chicks have a creamy white patch at back of head. The barred female chicks have darker down, sharper head spot and darker shanks than the males. This barring gene is inherited as a sex linked character in Barred Plymouth Rock breed.

TABLE 4.3
Characteristics of Fast and Slow Feathering

Fast feathering	Slow feathering
1. Well developed primaries. The covert isabout two thirds as long as and more slender than primary feathers.	Less developed primaries. The covert is of the same length as primary feather which is almost as slender as the coverts.
2. There should be atleast seven well developed-secondaries.	No visibly well developed secondaries.
3. At 10-days of age, the tail is about 1.25 cm in length and the wing feathers extend almost to the tail or beyond it.	At 10-days of age, there is no visible tail and the wing feathers do not extend beyond the body.

This Illustrates the Function of the Female in Determining the Sex of Progeny

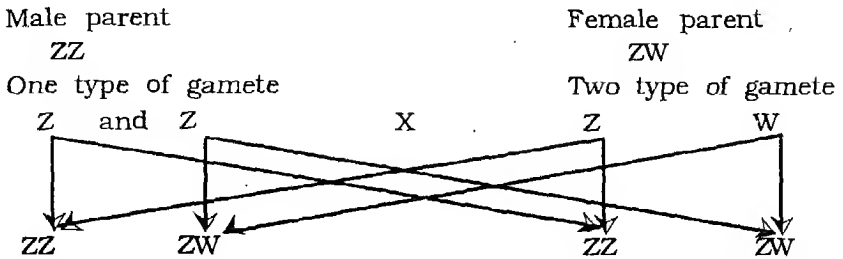


FIG. 4.7 Sex-determination in fowl

Use of Slow/Fast Feathering Pair of Characters in Differentiating Sexes at Hatching Time. See that the Dominant Gene is Present in the Female Parent and is Passed by the Female Parent only to her Sons.

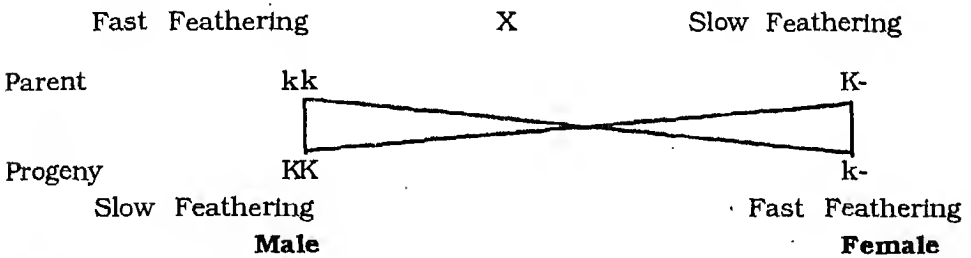


Fig. 4.8 Use of silver/gold pair of characters in differentiating sexes at hatching time.

Use of Barred/Unbarred Pair of Characters n Differentiating Sexes at Hatching Time. See that the Barring which is Dominant is Passed by the Female Parent only to her Sons.

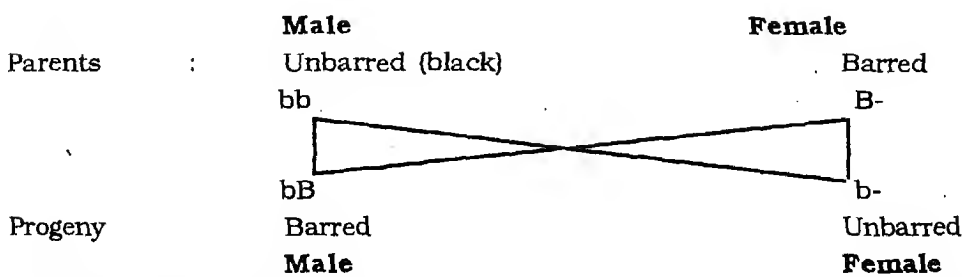


Fig. 4.9 Use of barred/unbarred pair of characters in differentiating sexes at hatching time

4.5.2.2 Silver-gold pair of character

Another kind of sex-linked cross, that enables the sex of the chicks to be distinguished at hatching time is the gold silver cross. All fowls are either silver or gold type. The gene 'S' for silver is dominant over the 's' for gold. They are located on the sex chromosome. These gold and silver colour are observed in solid black birds and in white ones. Any silver female, mated with a gold male produces chicks in which the males are genetically silvered and the females are gold (Fig.4.10). Phenotypically, the silvers appear white or silvery grey in colour and the gold female chicks appear with buff down colour (light yellow). Some of the favorite crosses are Rhode Island Red male mated to Light Sussex female and Buff Orpington male mated to Silver laced Wyandotte females.

Note : White Leghorn are silver type, but are useless as silver female in a silver-gold cross because of a dominant white character (Dominant colour inhibitor factor, 'I').

4.5.3 Vent Sexing

Though sex-linked genes for rate of feathering or colour pattern are being used by breeders to facilitate sexing when chicks are at day old, sexing by cloacal identification has been widely used by hatcheries to sex freshly hatched chicks. Identification of rudimentary copulatory organ or male process in the cloaca of male chicks at hatching can be used to identify sexes. For this considerable skill and accuracy is needed. This method was first practised by the Japanese and hence is also known as Japanese method of sexing.

Use of Silver/Gold Pair of Characters in Differentiating Sexes at Hatching Time. See that the Silver Gene which is Dominant is Passed by the Female Parent only to her Sons.

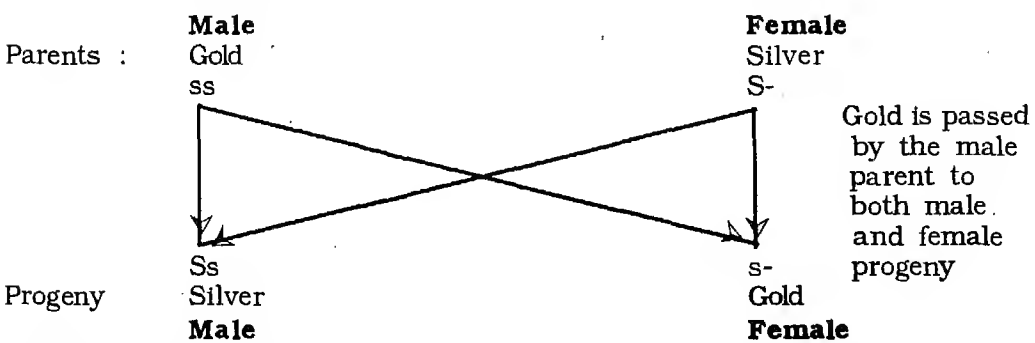


Fig. 4.10 Use of silver/gold pair of characters in differentiating sexes at hatching time.

QUESTIONS

1. What are Mendel's laws of inheritance ?
2. Make a monohybrid cross between pure dominant and pure recessive variety.
3. Write short notes on
   (a) Dominance
   (b) Heridity
   (c) Hybrid
   (d) Feather sexing
   (e) Vent sexing
4. Explain inheritance of comb pattern in poultry.
5. Explain inheritance of plumage colour in poultry.
6. Tick the correct answer (✓)
   (a) Phenotype of any bird is = Genotype + Environment. T/F
   (b) Genetic relationship between offspring and one parent is ½. T/F
   (c) Full sib have 50% genetic relationship. T/F
   (d) Major cause of relationship between two characters is pleiotropy. T/F
   (e) The h^2 of age at sexual maturity is about 0.30. T/F

CHAPTER 5

Components of Egg Production

Egg production is the most important economic trait in chicken. A commercial layer starts laying around at the age of 20 weeks and continues laying up to one year or so and then moults (shedding and renewal of feathers after continuous first year lay to allow a period of rest to the bird to get prepared for the next cycle of laying). Egg production drops sharply below the economical level after the first laying cycle. Therefore, the economical life period in chicken is considered to be 500 days or 72 weeks. Commercial layers therefore, are rarely maintained after first laying cycle that is after 72-weeks of age. Peak production is reached after about 5 to 6 weeks of laying the first egg. The peak rate of lay is maintained for 4 to 5 weeks after which it gradually declines.

The number of eggs a hen will lay during the laying cycle was believed to be dependent upon the following five components, which have got separate inheritance.

They are,

(i) Age at sexual maturity
(ii) Length of laying cycle (persistency)
(iii) The rate of egg production (Intensity)
(iv) Number of pauses during which no egg is laid.
(v) Number and duration of broody periods.

However later studies revealed that, the genetics of egg production is considerably more complex than was understood. However, the above partitioning has still got some relevance in poultry improvement. Age at sexual maturity, intensity and broodiness are considered to be very important in determining egg production.

5.1 Egg Number

Number of eggs produced by a hen in its biological year is an important consideration for assesing its economic survivability. However farmers consideration is to obtain maximum number of eggs which have marketable size. In foreign countries eggs are sold by weight grades therefore larger eggs have more market value. Whereas in the Indian market grading and packing is not practiced therefore number is more important than the size. The farmers choice therefore

rests with maximum number of eggs of medium size acceptable to the market.

5.2 Persistency

Persistency refers to number of functional days available to the bird for laying before onset of moulting at the end of the laying cycle. A hen which moults late or continues to lay during the moulting period is a good layer. Persistency is not important nowadays because present day commercial layers are invariably culled after the first year of lay. Persistency is an inherited trait and can be improved by appropriate method of breeding.

5.3 Intensity

The rate of egg production is referred to as intensity of lay. This is denoted by the number of eggs laid during a particular time interval. It is sometimes expressed in percentage. This character is highly subjected to environmental influence. The number of eggs laid by a bird is determined by the number of eggs laid without a break. This is called clutch.

A hen normally lays for a number of days in succession, at an interval of 24-27 hours., then misses a day or two (pause) and again starts laying consecutively for some days and again misses a day or two and so on. The clutch size varies form one egg to a fairly large number of eggs. Clutch size is longer and inter-clutch interval is shorter for a good layer. Clutch size is relatively more determined by genes, whereas rate of lay is more determined by environment.

5.4 Sexual Maturity

The hen is said to be sexually mature, when she lays her first egg. The earlier it matures, the longer is the biological year available and more the number of eggs are likely to be produced. However too early maturity is not desirable in commercial flocks because it affects egg weight adversely. There are important differences between strains of the same breed in age at sexual maturity. Probably many genes are involved in its inheritance and there is evidence of presence of some sex-linked genes affecting maturity. For this reason, an early maturity strain should be used as a male parent while planning to produce a strain cross commercial layer because the female progenies will carry the early maturing genes which they receive from their male parents. Environmental factors such as daylight, feed consumption during the growing period, sub-optimal management, month of hatching, etc. greatly influence this trait. Chicks hatched during March to May come into production earlier than those hatched in other months. It is relatively easy to develop early maturing strains by following appropriate breeding method.

5.5 Broodiness

Broodiness is the condition in which females stop laying and show a tendency for sitting on eggs. It is highly undesirable for commercial layers because it reduces number of functional days available to lay eggs. Mediterranean breeds are characteristically non-broody but Asian breeds show a strong tendency towards

broodiness. Strains of American breeds having originated from crosses of Mediterranean and Asiatic breeds show variable amount of broodiness. Broodiness shortens the biological laying year and the potential annual egg yield. Evidence suggests that, broodiness is determined by complementary effect of genes. American strains although bred consistently for freedom from broodiness, when crossed with Leghorns, their progenies tend to be more broody than their parents. This suggests that broodiness is determined by complementary effect of genes. Further broodiness has a sex-linked basis. The cross bred progenies of RIR male and Leghorn females show higher broodiness than cross between Leghorn males and RIR females (Fig5.1). To eliminate broodiness from a cross, the poultry breeders would need to make appropriate selection of pure breeds. The most effective way of reducing broodiness in a strain is to avoid using in matings any daughters of a dam that exhibited broodiness and any female and her sisters that exhibited broodiness, even though they are the progenies of non-broody female parent.

5.6 Egg Weight

Egg weight is an inherited character. Progenies of parents laying a good size egg also produce eggs of better size. So it is very easy to manipulate by appropriate breeding. Weight of the first egg laid by the pullet is about 75% of the maximum egg weight the pullet will reach when it is completely mature. The speed at which the pullet

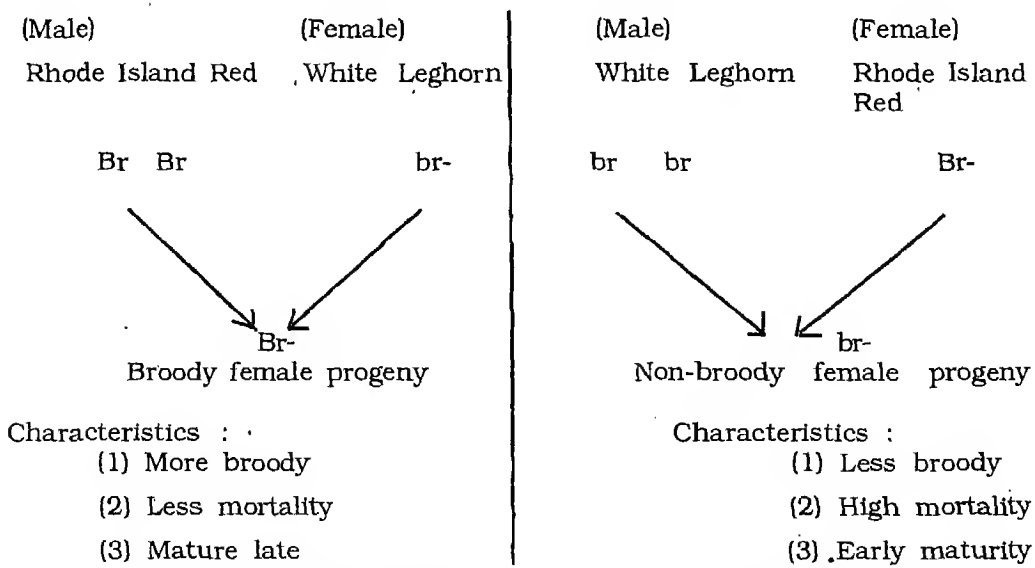


Fig. 5.1 Characteristic of the progeny of a cross between Rhode-Island Red (RIR) male and White Leghorn female and its reciprocal crosses.

reaches mature egg size is influenced by hatch date and age at sexual maturity. The egg weight is influenced by age at sexual maturity, body weight and rate of lay. Birds which mature early and those with high production potential tend to lay smaller eggs. Other factors affecting egg size are type of breed, nutrition, season and disease condition. A number of managemental factors may also affect egg size, such as eggs from birds housed in cages, are larger than those housed on the floor because in cages there is no competition for feed.

5.7 Body Weight

Body weight, otherwise called body size, is usually measured by weighing the birds. The body size is determined by the bone size and the degree of fleshing. Bone size is genetically controlled where as degree of fleshing is mostly determined by environment such as nutrition, management and disease. The length of shank is a better measure of the genetic size rather than the simple body weight. Body weight depends upon the rate of growth which is to some extent inherited. For birds, the rate of growth is characterized by a period of acceleration followed by a period of deceleration. The acceleration and deceleration are roughly divided at 12 weeks of age in broilers and at 16 weeks of age in turkey. The most economic growth takes place during the accelerated growth period (during this period for a given growth the feed consumed is less) compared to the period of deceleration. Rate of growth of shank, is a good index of the rate of growth of the body as a whole. Large body weight is very important in broilers. Small and intermediate body weight is preferred in layers. Optimum body size is very important in laying chicken to obtain optimum egg size.

Through the application of modern methods of breeding, feeding and management, it has been possible to develop rapid growing broilers which at 7 to 8 weeks weigh almost the same as 12-week old broilers weighed about 20 year ago. This has reduced the marketing age and in most cases they are now sold at as early as 6-weeks of age.

Conformation which is an expression of body proportions, indirectly also affects body weight. Some number of different body measurements will provide an accurate assessment of conformation like the breast angle, the keel bone length and shank length. The conformation is also determined by both bone structure and fleshing. In chicken the variation in conformation is due to differences in fleshing. Hence environment has lot of influence on it. Good body conformation is the abundant development of breast muscles over, a relatively long keel. For this reason birds with broad and fairly deep bodies with relatively long straight keel bone should be saved as breeders. For superior fleshing the breast and legs should be carefully examined because together they account for 45% of the dressed weight. Conformation is more important in broilers and turkeys. It is of little direct economic importance in case of layer

type of chickens.

5.8 Viability

Under the best circumstances the lifespan of an average chicken is relatively shorter, and hence frequent replacement is necessary. The commercial poultry man generally replaces his stocks every year but if his layers are profitable producers for second year, the annual cost of replacement would be reduced considerably. In recent year mortality has been definitely on an increase in most flocks of growing chicken and laying pullets. Much of the mortality is undoubtedly due to faulty management, inadequate housing, overcrowding, lack of sanitation and improper balanced diets. On the other hand a considerable proportion of the mortality in many flocks is due to low resistance of the flocks to disease organisms of one kind or other. There are three possible methods of disease prevention available to the poultry man. The first is sanitation, the second is through use of therapeutic agents and the third is breeding for resistance to disease. As explained earlier, the breed and strain differences in disease resistance do exist and resistant to disease is generally dominant to susceptibility. Probably several genes are involved in the inheritance of disease resistance. Therefore, by following appropriate breeding methods, the viability can be improved genetically. Because of the large number of diseases with which chicken are affected, breeders normally do not deal with individual diseases but prefer to select for general resistance to diseases. When a particular disease becomes a serious problem then selection for specific resistance is likely to be incorporated into the breeding programme. Factors like inbreeding do reduce viability and crossbreeding, in general, tends to increase viability because of heterosis.

5.9 Feed Efficiency

Feed efficiency in layer type chickens is measured either as amount of feed consumed in kg per dozen of eggs or as amount of feed consumed in kg per kilogram of eggmass. Substantial improvements in the conversion of feed into eggs have been realized in commercial stocks. The improvement in feed efficiency is, in fact, primarily due to the increased eggmass which today's hen produces. The requirements of hen for eggmass production and body weight explain a major part of variability in feed intake. So estimation of feed consumption can be made efficiently without direct measurement of feed intake. Till date breeders were relying to improve feed efficiency indirectly by breeding for increased production. But there are limitations which will face the breeder in not too far distant future. As peak rate of lay approaches 95% in most of the commercial stocks the breeder faces the natural limit of one egg per day. This is imposed by the fact that, only one egg at a time can be formed by the hen without being misshapen or shell-less. Since feed efficiency has a genetic basis, the future rests on breeding, poultry for efficient conversion of feed to product output.

In case of broilers, feed efficiency

is a ratio of feed consumption to weight gain. Primary demand in the poultry meat industry has been for a fast-growing bird that is an efficient convertor of feedstuffs to edible product. Breeding for rapid growth in broilers meant that, broilers reached market weight at younger ages, and thus feed efficiency was improved primarily from savings in the feed consumed for maintenance. It has been estimated that a reduction of one day in reaching market weight reduces feed consum-ption per bird by 50 to 60 g. Since the main objective of breeders of meat type chicken was to produce a fast growing broiler, they were indirectly depending to improve feed efficiency through broilers reaching market weight at younger ages. However, it was soon realized that, little genetic improvement has occurred in this trait. So in recent years emphasis have been given to directly breed for improved feed efficiency.

QUESTIONS

1. Explain the biological year of a hen for egg production.
2. Describe various components affecting egg production in chicken.
3. Write short notes on
   (a) Persistancy
   (b) Clutch size
   (c) Sexual maturity
   (d) Broodiness
4. Tick the correct answer (✓)
   (a) Egg weight is highly heritable in chicken. T/F
   (b) Body weight is lowly heritable in broilers. T/F
   (c) Conformation refers to body proportion in broilers. T/F
   (d) Measurement of feed efficiency is important in broilers. T/F

CHAPTER 6

Methods of Mating

6.1 Flock Mating

In this method two or more groups of males are mated with a flock of several females. A ratio of one male to 12-15 female is a good proportion. Light breeds male accommodate more females than the heavy breeds. Males used for longer periods often show a decline in fertility and such cases can be corrected to some extent by substituting a new batch of males in place of those which have been in the flocks.

6.2 Pen Mating

In this method one male is being continuously mated with 10-15 females for egg type stocks and 5-10 females for meat type stocks. These are practiced largely by poultry breeders who trapnest the females and hatch the chicks from each female separately, so that the sire and dam of each chick is known. In certain pen matings, a male may refuse to mate with certain females or vice-versa. Changing the females showing poor fertility to another pen often corrects the trouble. In turkey the male to female ratio is narrow because of heavy body size. In quails a mating ratio of one male to 2 to 3 females is essential to obtain, desired fertility.

6.3 Shift Mating

In breeding to develop high egg production lines, it is desirable to secure a reasonable number of progeny from a large number of males and females. Each male should be mated to atleast 6 to 10 females and many such pen matings should be maintained every year. In order to test as many males as possible with different females, the males can be shifted to other pens during the breeding season. When a shift is made, at least 10-days gap must be left in saving hatching eggs between the time the first male was taken out and the second male put in to be reasonably sure of the sire of each chick hatched. This method of mating in shifts is called shift mating.

QUESTIONS

1. Describe the common methods of mating in poultry.
2. Tick the correct answer (✓)
   (a) In flock mating male female ratio is kept 1:10. T/F
   (b) In pen mating one male is mated with 5-6 females of meat type chicken. T/F

CHAPTER 7

Systems of Breeding

7.1 Inbreeding

Inbreeding involves the mating of closely related individuals, such as, mating of full brother to full sister or mating of a sire to his daughter or dam to her son. Inbreeding increases the frequency of homozygotes at the cost of heterozygotes. As a consequence brings together undesirable as well as desirable genes. Since many recessive genes have less desirable effects than dominant genes inbreeding has the effect of unmasking the presence of these undesirable recessive genes whose effects were masked by the presence of desirable dominant genes. It is when these undesirable recessive genes occur in a homozygous condition that they are able to produce undesirable characters. The appearance of the undesirable characters in inbred lines makes it possible for the poultry breeder to eliminate rather quickly numerous undesirable characters from his flock. Inbreeding, if accompanied by intelligent selection, makes rapid improvement possible because superior families can be readily separated from inferior families. The primary objective of inbreeding is to develop lines which can be commercially used. Inbred line should be developed only from outstanding stocks and selection should be practiced rigorously among the lines, only the best being allowed to perpetuate. The chosen lines must reproduce well and must combine well for production of commercial chicks. To practice proper selection the number of lines to start with should be several times greater than the lines to be obtained. Inbreeding is a very costly way to produce chicken. Many strains do not survive the inbreeding phase. However, such elimination of lines during the process of inbreeding eliminates the undesirable genes because of which eventually when these lines are crossed progenies with better performance are obtained.

7.1.1 Inbred Line

A group of inbred chicks, resulting from breeding closely related poultry, and in which the individuals in question have an average coefficient of inbreeding of 50 percent, equivalent to 3-generations of full-brother-sister

mating or 6-generations of half-brother-sister mating is termed as inbred line (Fig.7.1 and Table 7.1).

7.2 Cross Breeding

Crossing among breeds is generally called crossbreeding. The purpose is to combine many different genes from many wildly separated sources. Since most of the favourable characters in each of the pure bred parents are due to the effect of dominant genes, it is obvious that the crossbred progenies, contain many favourable dominant genes in a heterozygous condition, some of the dominant genes having been received from one pure bred parent and some from the other. Many dominant genes produce many favourable effects, than do recessive genes, so that the progenies produced by crossbreeding are usually superior in many characters over either of the parental breeds used to produce it. This superiority is due to haterosis or hybrid vigour. So the term hybrid is designated to progenies of a crossbred mating.

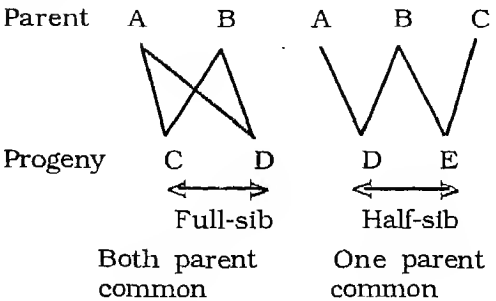


Fig. 7.1 Inbred Line

The real purpose of crossbreeding is to combine the desirable qualities from two distinct lines of stocks into one. A beneficial result can only be expected from crossing of two completely unrelated lines or breeds which have been selected for certain desirable characteristic and they breed true for those characters (Fig. 7.2).

The Effect of Crossing Two Pure Breeds. Note that the Cross Breds are Heterozygous for all the Traits.

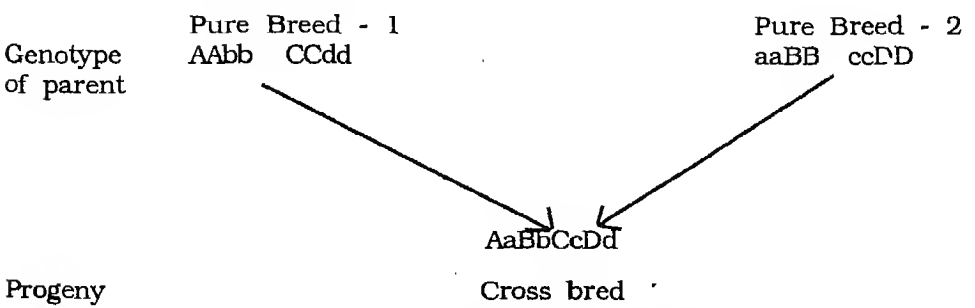


Fig. 7.2 Crossbreeding

TABLE 7.1
Rate of Inbreeding

Generation	Full-sib mating	Half sib mating
G0	0.0%	0.0%
G1	25.0%	12.5%
G2	37.5%	22.0%
G3	50.0%	30.0%
G4	59.0%	38.0%
G5	67.0%	45.0%
G6	73.0%	51.0%

Full-sib mating - 3 generations necessary to achieve 50% inbreeding.

Half-sib mating - 6 generations necessary to achieve 50% inbreeding.

7.2.1 Strain Crossing

Within breeds there are strains that may be quiet unrelated to each other or have little recent common ancestry.

Many of these strains represent efforts of many small poultry breeders to select and improve their purebred stock. Some of these strains, when crossed, give offspring that perform considerably better than the parent strains.

7.2.2 Hybridization

Hybridization is a type of crossbreeding where systematic crossing of specific breed/ strain/ inbred lines is carried out. The purpose is to obtain maximum advantage from non-additive genetic variance which is expressed as superiority of crossbred over that of the parents. This superiority can be expressed as deviation from average values of two parent or that of the best parent. The heterosis thus obtained is expressed in percentage.

Heterotic advantage obtained after resorting to crossbreeding is lost about 50% in each generation if intense mating is practiced in future generations to establish the population genetically.

7.2.3 Advantages

(i) Cross breeding or hybridization allow the combination in one animal of several important characters found separately in three or four parent breeds or strains.
(ii) It is the quickest method of producing the required commercial progeny.
(iii) It is a flexible system because, it allows quick modification, by one or more parental breed substitution.

QUESTIONS

1. Enumerate different breeding methods in chicken.
2. How are inbred lines developed in poultry ?
3. Give merits and demerits of inbreeding in poultry.
4. Write short notes on
   (a) Hybridization, (b) Inbred lines and (c) Strain crossing

CHAPTER 8

Fertility and Hatchability

Fertility and hatchability for a flock are expressed as percentage in relation to total eggs set. Hatchability is also expressed in percentage of fertile egg set.

8.1 Factors Affecting Fertility

The poultry breeder should always remember that, the percentage of fertile eggs secured is the first factor in determining the number of chicks secured in proportion to the eggs set. Various factors related to management, nutrition, disease, season, etc. affect fertility.

8.1.1 Management Factors

Proper management of the breeding flock is important in order to secure maximum fertility.

i. To improve fertility in a flock the ratio of males to females should be kept optimum. The ratio should be narrow for heavy breeds than for light breeds.

ii. In order to avoid injury to the females at the time of mating, it is advisable to trim the spurs and toe-nails of the males if they are long and sharp.

iii. There is frequently excessive fighting among males in a large flock of females. This often leads to reduced fertility but can be avoided to a considerable extent by debeaking or removing of about one quarter of the upper mandible of each male with a sharp knife or debeaker.

iv. Under ordinary circumstances, cockerels (young mature males) give better results in fertility than cocks, because as the age of the male increases, fertility decreases. This is especially true in case of males of the heavy breeds. So it is rarely advisable to use males over two years of age.

v. Pullets and matured hens usually give about the same result in fertility, with a slight advantage in favour of pullets. After the first year of lay, fertility tends to decline with advancing age.

vi. Flocks mated for several months often show a decline in fertility. Frequently this decrease can be avoided to some extent by substituting a new batch of cockerels in place of old ones.

vii. In certain pen matings, a male

may refuse to mate with certain females or vice-versa. This is called social order. Changing the females showing poor fertility to another pen often corrects the trouble.

viii. Flocks in high rate of lay have better fertility than poor producing flocks.

ix. When artificial insemination is practised large number of females can be inseminated with the semen of a single male. A dose of 0.1 ml of semen once each week for each female gives good fertility. Best result is obtained if insemination is done, either soon or ½ - 1 hour after the bird has laid the egg. Poor fertility is obtained if females are inseminated during the morning because at that time the uterus contains a fully formed egg.

x. In order to secure maximum fertility, before starting to save eggs, it is well to make up the matings at least 10-days in advance. A high percentage of fertile eggs is not likely to be obtained within 5 to 7 days after making up a mating.

xi. It is possible to secure fertile eggs for as long as 21-days after copulation has taken place but the percentage of fertile eggs tends to decline about the fifth day and declines sharply following the tenth day after the males have been removed from the breeding pen.

8.1.2 Nutrition Factors

i. Poorly fed birds tend to give lower fertility compared to well fed birds. This is particularly important in the case of males because many of them are inclined to eat too little when running with females. This can be corrected to some extent by providing feed hopper for males that are out of reach of the females.

ii. Feeding of breeding females needs special attention. The breeder ration should be fortified with minerals and vitamins for obtaining better fertility.

8.1.3 Disease Status of the Flock

In the birds affected with various bacterial and viral diseases, there is reduction in fertility. So such type of sick birds should be replaced with healthy one to get good fertility.

8.1.4 Seasonal Factors

i. There is a reduction in fertility during extremely hot weather, particularly when temperature rises above 37.8° C. Properly insulated and well ventilated poultry houses can maintain a good fertility level during the warmer seasons of the year.

ii. Extremely cold weather also causes a lowering in fertility. So special precautions should be taken to keep the house comfortable, when the temperature drops suddenly. In order to avoid frost bite to the combs of males, dubbing should be practised.

8.1.5 Genetic Factors

Fertility is to some extent inherited

and can be improved by following appropriate breeding methods.

8.2 Factors Affecting Hatchability

Several factors such as the biological requirements for incubation, the egg quality, handling of hatching eggs, fertility rate, genetics, nutrition and health condition of the flock affect hatchability.

8.2.1 Biological Requirements for Incubation

The biological requirement of incubation can be interpreted in terms of :
(i) Temperature
(ii) Humidity
(iii) Air supply
(iv) Position and turning of eggs.

8.2.1.1 Temperature

The optimum incubation temperature is influenced by stage of incubation, make and type of incubator, humidity of air during incubation, age of eggs, size of eggs and egg shell quality. For an average egg, the optimum incubation temperature in forced draft incubator is 37.5° to 38°C during the first 17 days and 36.1° to 37.2°C during the last four days of incubation. The optimum incubation temperature in still air incubators is about one degree Fahrenheit more than forced draft incubations. Sub-optimal temperature lengthens hatching time and affects the development of embryo and thereby hatchability. Similarly super-optimal temperature shortens the period of incubation and are highly detrimental for hatchability. Due to electric failure, fans do not distribute air properly. Consequently the hot air rises to the upper portion of the incubator and causes over heating of the eggs. During the first 19-days of incubation such a situation may not effect the hatchability to a great extent but if it occurs during the last two-days, the hatchability is reduced to a great extent.

8.2.1.2 Humidity

The amount of moisture present in air to what it is capable of holding at that temperature is known as relative humidity. Humidity surrounding the egg effects the hatchability. Too much humidity shortens the incubation period and too little humidity lengthens the incubation period. During the first 19-days of incubation, too little humidity causes the chicks to be smaller with dehydrated shanks and too high humidity results in larger chicks with softness of abdomen. In both cases, the hatchability will be reduced. The ideal relative humidity should be around 60 percent during first 17-days and 70 percent during last 4-days for optimum hatchability.

8.2.1.3 Air supply

The developing embryo in their metabolic process utilize oxygen and release carbon dioxide. The process of oxygen intake and carbon dioxide output increases 100 fold between the first and 21st day of incubation. The optimum oxygen concentration for hatchability appears to be the concentration present in the air, that is 21%. Embryos are more susceptible to deficiency of oxygen than to excess.

Each 1% drop in oxygen concentration below 21%, reduces hatchability by 5%. Reduction in hatchability in high altitudes is due to lesser oxygen in air. Embryos are highly susceptible to increased carbondioxide concentration. Carbondioxide concentration should not exceed 0.5% inside the incubator as its higher concentration decreases hatchability and it becomes zero at 5% level of carbon-dioxide. For this reason it is essential that the room in which the incubator is installed has adequate ventilation.

8.2.1.4 Position and turning of eggs

Fertile eggs are loaded into the incubator with broad end up. The hatchability decreases, when the eggs are placed with narrow end up: This reduction is because the beak of embryo with head at narrow end, cannot penetrate the air cell when pulmonary respiration commences. During 20th and 21st day of incubation the position of eggs do not influence hatchability.

Turning of eggs in the incubator is very essential as it improves hatchability. The eggs should be turned 45 degree to each side from vertical (total 90 degree) quickly giving resting period at each time. Turning less than 45 degree to each side from the vertical lowers hatchability. Eggs should be turned atleast 6 - 8 times a day. Turning is essential because the developing embryo does not stick to one side of the shell wall. The eggs need to be turned only during the first 17 days of incubation.

8.2.2 Egg Quality

8.2.2.1 Egg size

Egg size influences hatchability. Eggs weighing 50 to 59 grams hatch better than small or extra large eggs.

8.2.2.2 Egg shape

Eggs that deviate from normal shape have lower hatchability.

8.2.2.3 Shell colour

Eggs that are darker in colour hatch better.

8.2.2.4 Shell quality

Cracked, rough or thin shell lowers hatchability.

8.2.2.5 Internal quality

Eggs having blood spot, misplaced air cell and tremulous air cells, hatch poorly.

8.2.3 Handling of Hatching Eggs

The handling of hatching eggs from the time the egg is laid is very important to secure good hatchability.

8.2.3.1 Collection of hatching eggs

Eggs should be collected at least four times a day. The nests should be clean to produce clean eggs. The birds should be trained to lay egg in the nest. While collecting eggs care should be taken to keep the eggs in the filler flats with the large end up (to keep yolk away from shell membrane). Large end down causes tremulous air cell

and stroking to shell. Extra large eggs, double yolk eggs, misshapen eggs, cracked eggs, etc. should be separated. In a good system of collection the cracking of eggs between the time they are laid and set in the incubator should be less than 1%.

8.2.3.2 Sanitation of hatching eggs

The eggs in a litter floor contain about 20 to 30 times more microbial load than the eggs produced in wire floor houses. The microbial built up on eggs has adverse effect on hatchability. The eggs may be decontaminated by sanitization measures like fumigation (20 g potassium permanganate with 40 ml formalin), or spraying quaternary ammonium compounds (200 ppm in lukewarm water) or chlorine dioxide (80 ppm in lukewarm water). The eggs has to be decontaminated in the poultry house itself as soon as it is picked up to keep the microbial load down to minimum.

8.2.3.3 Storage of hatching eggs

The optimum temperature for storing hatching eggs is about 15.5°C for eggs stored less than a week and 12.8°C for eggs stored for longer periods. For good hatchability the eggs must be cooled gradually taking about a day to reach the storing temperature.

During the storing period evaporation of moisture from eggs should be minimum for maximum hatchability. The optimum relative humidity to be maintained in the storing chamber should be 75 to 80%. Humidity more than this, causes problem of wetting of egg-cases, thereby developing chances of fungal contamination leading to reduced hatchability.

Hatchability decreases with increase in storage period of eggs for more than five days. After the first five days of storage, each additional day of storage decreases hatchability by about 4% and increases hatching time by 20-minutes.

If eggs are to be stored for longer periods, the hatching quality of eggs can be maintained by enclosing the eggs in plastic films inside the egg case. Nitrogen gas may be flushed in the egg area and the plastic films may be sealed. In few hours, moisture escaping from eggs raises the humidity and slows further evaporation.

If hatching eggs are to be held for not more than a week, position of eggs in the storage room is of no consequence. They can be held large end up or in the horizontal position.

In the storage room, for more than five days storage the eggs need to be turned at least once a day. This prevents contact of developing embryo with shell membrane.

8.2.3.4 Washing of hatching eggs

Hatching eggs should never be washed, unless exceptional circumstances demand it because washing reduces hatchability by exposing the pores. By washing the cuticle of the shell and development of cracks on the shell surface. Under special circumstances, it may be necessary to dip the eggs in antibiotic solution as a measure of precaution against certain diseases. Egg dipping normally reduces hatchability by 2 to 5%. In this the

eggs are preheated at 39.1°C for 6 hours and placed in a special tank containing antibiotic solution at 7.2°C for 5-minutes.

8.2.3.5 Transfer of eggs to incubator

The hatching eggs should not be placed directly from cool egg storage room into the incubator. The eggs should be first warmed to room temperature for 6 to 8 hours and then placed in the incubator. If cool eggs are placed in the incubator, sweating of eggs occur resulting in drop in incubator temperature for some time, resulting in lowered hatchability and increased time for hatching.

8.2.4 Fertility Rate

The fertility is influenced by several factors as described earlier. Factors which reduce fertility in turn effect hatchability significantly.

8.2.5 Genetic Factor

Hatchability is very low in highly inbred populations. Egg structure and genetic constitution of the embryo are inherited and these factors indirectly affect hatchability. There are about 30-lethal genes that are known in poultry. These genes are those that may cause death of the developing chick before the end of incubation. These genes when present, may effect hatchability of eggs from a breeder flock.

8.2.6 Nutrition

The content of major nutrients like carbohydrate, protein and fat are not affected in the egg by the diet the hen consumes. But the diet has a pronounced effect on the content of vitamins, minerals and micronutrients which influence hatchability. The deficiency of the diet of these factors lowers hatchability. Hence the diet of breeding flock must be fortified with the essential vitamins, minerals and micro nutrients.

8.2.7 Disease

Disease caused by salmonella organisms such as pullorum disease are the major group of bacterial infections that influence hatchability. Salmonella organisms may be passed from infected hens to eggs. The infected eggs don't hatch well. Other diseases like Newcastle disease, 76-egg drop syndromes and infectious bronchitis may not pass from infected hens to eggs but they affect egg shell quality and thus affect hatchability. Therefore, hatching eggs should always be collected from pretested healthy flocks.

8.3 Pedigree Hatching

Application of any systematic breeding programme for the improvement of poultry requires proper identification of birds and its pedigree. The proper recording of the pedigree demands identification of individual ancestors. This is done by keeping proper records starting from hatching of chicks. In poultry the identification of chicks at the time of hatching is quite complicated because generally several pullets are housed in a single pen along with the males for production of hatching eggs, which are of the same

colour. Thus it becomes more difficult to identify the eggs belonging to a specific female unless some method of identification is followed. Further, eggs are incubated in mass in the incubator, thus making the task more difficult to identify the hatching chicks for their parentage directly in the hatchery. Therefore, in practice the eggs are generally marked while collecting from the breeding pen by following the undermentioned procedure.

8.3.1 Identification of Breeders

Breeders are identified by using wing-bands (wing badge) or leg bands. The wing bands or leg bands are usually made up of aluminum and are put in wing/legs of the birds for identification as per the mark present on it. Wing badges are made of plastic and placed on wings.

8.3.2 Single Sire Mating

One cock is allowed to mate with a group of hens in a single pen. The pen number would then indicate the sire number and the eggs laid in that pen and are identified for that cock.

8.3.3 Identification of Eggs

One of the most important steps in collecting pedigreed hatching eggs is identification of eggs laid by a particular hen. This is done in two ways.

8.3.3.1 Individual cages

In this method breeding pullets are put in individual cages and an artificial method of insemination is followed with semen. The fertile eggs are produced and marked according to its parentage. In this method there are more chances for production of cracked eggs.

8.3.3.2 Trapnest

Trapnest is a nest, with a trap door by means of which, the bird shuts herself automatically when it enters into it to lay an egg. The egg recorder would release the bird after identification of egg. One such trapnest is sufficient for three birds.

8.3.4 Marking of Egg

Marking in eggs is generally done with a blunt and soft pencil. The general practice is to write the sire number and dam number after holding the broad end up. If needed the date may be mentioned below (Fig. 8.1).

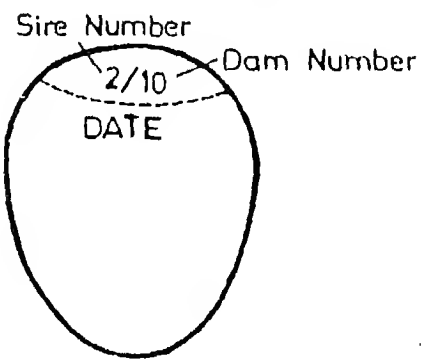


Fig. 8.1 Marking of eggs for pedigree hatching

8.3.5 Handling of Pedigreed Eggs

Pedigreed hatching eggs are generally sorted according to sire and dams daily

and packed in filler flats with broad end up. The usual practice is to set the eggs in incubator once a week to get adequate number of progeny per dam at a time. Therefore, the hatching eggs are stored in cooling chamber up to one week before setting (Fig. 8.2 and Fig. 8.3).

8.3.6 Hatching of Eggs

The eggs are set in the tray according to sire and dam numbers in sequence in a setter machine.

The eggs are candled at 18th day of incubation and transferred to hatcher machine in hatching trays after removing the infertile and dead germs. The eggs are put into pedigree hatching boxes along with a paper mark carrying the identification of eggs.

8.3.7 Identification of Chicks at Hatching

The chicks at the time of hatching are identified by putting wing bands. The number of wing band of each chick is entered in the hatching register along with its sire and dam to keep a proper record of pedigree.

8.4 Commercial Hatching

The aim of the poultry breeder is to produce or develop two different lines/ breeds/ strains that when crossed produce superior crossbred progenies which are called as commercials. Once the breeder has developed two lines he is left with the job to cross them to produce as many as commercial progeny (layer or broiler) to be supplied

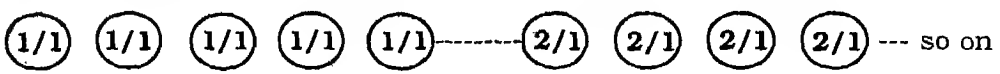


Fig. 8.2 Arrangement of hatching eggs in sequence according to sire and dam number during incubation.

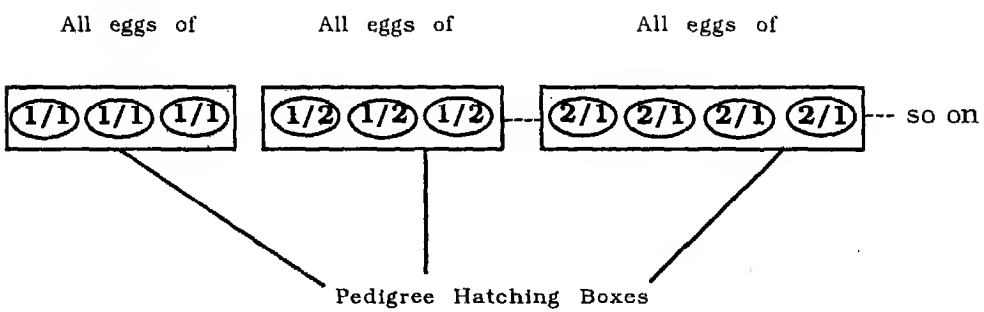


Fig. 8.3 Arrangement of hatching eggs in pedigree hatching boxes according to sire and dam number

to the farmers. This method of hatching is called commercial hatching. In this method there is no need of identification of eggs as per its parentage because pedigree is of no significance here. Under such a method, mating is practised where two or more males are mated with several females housed in a single pen. The hatching eggs are collected and set randomly in the setter incubator. On 18th day eggs are transferred to hatcher. machine and the hatched chicks are collected as such without putting any wing band and supplied to the farmers.

QUESTIONS

1. What are the factors affecting fertility and hatchability in chicken?
2. Give the biological requirements of incubation of chicken egg.
3. What precautions will you take in storage of fertile eggs? How many days fertile eggs can be stored ?
4. Write short notes on
   (a) Pedigree hatching
   (b) Identification of chick at hatching
   (c) Commercial hatching

CHAPTER 9

Modern Breeding Methods

Poultry includes several kind of birds such as chicken, ducks, geese, turkeys and guinea fowl. These are bred primarily for egg and meat production. Some breeders also maintain fancy birds for show purpose like pigeons, pheasants, parakeets, peacocks, etc.

Increased poultry production can be achieved by selective breeding and other novel breeding techniques. The breeding technique increases the inherent genetic potential of the birds. Improvement of genetic constitution of the birds will also require improved husbandry practices.

9.1 Breeding System in chicken

A hen may be saved or culled for the breeding purpose depending on the desirability of its records. One can select the bird or a group of birds with the higher record from population. This is called individual selection. In general, individual selection or mass selection is used for highly heritable traits. On the basis of estimates obtained by various workers body weight, egg weight, body measurement, shell quality, rate of feathering and sexual maturity are highly heritable. On the other hand egg production, hatchability, viability are lowly heritable traits, for which individual selection would not be effective. For lower heritable traits family selection is generally advocated. Family in poultry is referred to a group of full and half sibs. The difference between family and individual selection can be demonst-rated as follows (Table 9.1).

If selection is based on individual

TABLE 9.1
Individual Egg Production Record

Family group	Annual egg production									Family average
	100	120	140	160	180	200	220	240	260	
A	A1	A2				A3				140
B	B1						B2	B3		200
C	C1	C2					C3			155
D						D1	D2	D3		200
	Total Average									173

merit half of the birds are to be culled if selection point is above 180 eggs i.e. only A3, B2, B3, D2 and D3 will be selected. If family selection is to be resorted, only family group B and D are to be selected. Besides these common methods of breeding other methods those are practiced nowadays are:

(i) Inbreeding and hybridization, and
(ii) Reciprocal recurrent selection.

Inbreeding is the mating of individuals more closely related like brother sister, parent offspring, cousin brother, sisters, etc. Inbreeding increases the amount of homozygotes at the expense of heterozygotes. When two inbred lines are crossed, the progeny is generally superior to both the parent, and this is called heterosis.

The object of reciprocal recurrent selection is to find out and develop strains whose genes combine most effectively to produce offspring that are superior in performance. This system is also designed to secure the maximum benefits of heterosis without resorting to inbreeding. In this system the selection is based upon the ability of individuals of one strain to "nick" well with individual of the other strain.

In more practical situations, the breeder wishes to produce a strain having optimum breeding weight, high rate of lay and good egg weight. This involves using selection indices for choosing birds for breeding. A selection index is a number intended to be proportional to an individual's breeding value and therefore usable as criterion for selecting or rejecting the individual. It is made by combining credits for the individual traits and penalties for its defects.

9.2 Method of Selection

Methods of selection which are commonly used for layers, quails, ducks and turkeys are:

(i) Tandem method
(ii) Independent culling level method
(iii) Total score method.

9.2.1 Tandem Method

In this method selection is done for improvement of one character at a time until that is improved, then for a second character and later on for a third, until finally all the characters are improved to the desired level.

9.2.2 Independent Culling Level Method

In this method selection is done by fixing a level for each trait. All the characters are simultaneously taken into consideration and if any character is below the fixed level, the individuals will be culled no matter how good they are in other characteristics.

9.2.3 Total Score Method or Index Method of Selection

This is done by adding the individual's score for its merits in X characters to its score for merits in Y and Z, etc. and penalizing for demerits in others. This way a score is formed for each individual and higher score individual will be selected.

The tandem method is least efficient. Independent culling level method cannot be as efficient as total

score method. Total score method permits unusually high merit in one characteristic to make up for slight deficiency in the other. However, independent culling level method has the practical advantage that if the character has been developed, selection may be predicted without waiting to measure the later characteristic and making total score.

9.3 General Information on Species/ Type other than Layer

Breeding system and selection methods in layer are basically similar in other species and types. General information in some of these types/ species is summarised here.

9.3.1 Broilers

The broiler production is relatively a new branch of poultry industry in India. A broiler is a chicken raised exclusively for meat purpose up to 6 to 7 weeks of age. The characteristics of major importance in developing broiler chickens are growth rate, feed efficiency, mortality, feathering and carcass quality.

Besides there should be a reasonably good reproductive efficiency, fertility and hatchability for which specialized sire and dam lines are synthesized.

9.3.2 Quails

Quails popularly known as "*Bater*" in Hindi belong to class Aves, family Phasianidae and genus *Coturnix*. They are hardy and can be adopted to varied environments. It is a fast growing bird with short generation interval and high rate of lay. The females are heavier (150 to 180 g) than the males (120-150 g). The average age of first egg is about 50 days and they are in full production at about 60 days. Quail eggs are multicoloured ranging from dark brown, blue, white to buff each mottled with black, brown or blue colour. Approximate weight of egg is about 10 g (6.7 to 13.7 g). Total egg production in a year ranges from 250 to 300. One male should be mated to 3 females for good fertility and hatching eggs are collected after 4-7 days of putting males. The incubation period is only 18 days. The eggs are transferred from setter to hatcher on 14th day. Males and females are separated as soon as possible and reared separately.

9.3.3 Ducks

The duck belongs to the family Anatidae. The male duck is known as drake and the female as duck.

The domesticated duck belongs to the genus *Anus Anas* and species *platyrhynchos*. The young ones are called ducklings. Ducks are next to chicken in table egg production. The few facts which are favorable for duck breeding are :

- Ducks lay about 40 - 50 eggs more than chicken.
- Duck eggs are 15 to 20 g heavier than chicken eggs.
- Ducks require lesser attention than chicken.
- Ducks lay economically in second year of production and hence expenditure on replacement is saved.
- Ducks lay eggs in the morning hours i.e. at about 9 AM.
- Ducks can be tamed easily to go

to ponds and come back in the evening.

- Ducks are suitable for backyard keeping.

The optimum weight of hatching egg is 70-75 g. The incubation period is 28 days. The egg type ducks start laying at 20 weeks of age. For obtaining fertile eggs one drake is allowed to mate to 5-6 ducks. Stud mating is very popular.

9.3.4 Turkey

Turkeys are bred for meat purpose only and their meat is considered festive food. They can adopt to wide variety of agro-climatic conditions. About 95% of the commercial turkeys are crosses of one kind or other. Mostly 2 or 3 way crosses are very common. Turkeys are selected for rapid growth and wide breast conformation. Male turkeys are very heavy and may not work properly under natural mating. Artificial Insemination (AI) is commonly used to obtain fertile eggs from turkeys. Turkeys are seasonal layers. The average age at first egg is around 30 weeks. With adequate feed and management turkey hens lay as much as about 100 eggs in a year. The egg weight is about 1.5 times that of chicken egg i.e. about 85 g. Hatching period is 28 days. With optimum hatchability, 50-60 pullets are expected from each breeder hens. Turkeys are not used after one year due to reduced fertility and high cost of maintenance. Optimum market age is around 12-14 weeks when they achieve about 4 kg body weight. Turkey hens are also sold as roosters at about 20-24 weeks of age when they achieve a body weight of about 8-9 kg.

QUESTIONS

1. Enumerate modern breeding techniques for egg production in chicken.
2. Explain common methods of selection used for layers, broilers, ducks and turkeys.
3. Write short notes on
   (a) Inbreeding hybridization
   (b) Reciprocal Recurrent Selection (RRS)
   (c) Total score method of selection.
4. Tick the correct answer (√)
   (a) Tandem method is superior to independent culling method of selection. T/F
   (b) Total score method is superior to tandem and independent culling method of selection. T/F
   (c) Ducks lay about 40-50 eggs more than chicken. T/F
   (d) The egg weight of turkey egg is about 85 g. T/F

CHAPTER 10

Selection and Culling

10.1 Culling

Selection of good layers and removal of birds which are not in good condition or are poor in growth and production is called culling. Commercial flock owners use this method of identifying the layers from that of non-layers in order to cull the uneconomical producers at different times during the laying year. It plays an important role in the efficiency of the farm as, by feeding unproductive birds, the poultry farmer can never get profit. These uneconomical birds are also a constant source of infection. Hence culling should be carried out regularly to remove weak, emaciated and unproductive birds.

Culling should start from day old stage and continued till the birds are finally disposed of. At day old, accept only healthy chicks and all those chicks which have body defect, under weight, stunted should be rejected. Any off coloured and dull bird should not be kept.

In case of layer flock at 8 weeks any bird with subnormal body weight and featherless should be culled. At 20 weeks also any unhealthy and poorly grown pullet should be removed. Farmers should know the difference between layers and non layers. Non layers must be culled for table purpose (Table 10.1).

10.1.1 Handling for Examination

The bird should be held in the natural position so that body of the bird rests on the palm of the left hand. Examination of the bird may be done by right hand. It is desirable to do culling in the evening or even in the night. Birds should not feel stress or excited while handling.

10.2 Pigmentation

The yellow pigmentation in the body of the bird is stored at the time of growth. At the start of laying it is discharged. The order of depigmentation will start from vent first. The vent of a good layer becomes white in two weeks of laying. After two weeks eyes and ear lobes start loosing the pigment. The beak looses the yellowness within 6-8 weeks of intense egg production while in poor layers this pigment is retained. Shanks lose their yellow pigmentation in good

layers after 24-30 weeks. The restoration of pigmentation takes place in the same pattern as the de-pigmentation. It will be restored in the vent first and then eye ring and ear lobe and so on. In the good layers moulting i.e. shedding of feathers will start late and is quicker. Even during moulting good layers will continue to lay. In poor layers the moulting starts early, is slow, and it stops laying during this period.

TABLE 10.1
Guidelines for Differentiating Layer from Non-layers

Characteristics	Keep	Cull
i. Health and vitality	Vigorous, active, good capacity	Weak, sluggish, under sized, lacking capacity
ii. Comb and wattles	Full, smooth, glossy, bright red	Shrunken, dry, dull, pale scarcity
iii. Eyes	Prominent, keen, sparkling	Shrunken, lightless
iv. Vent	Large, smooth, moist, cleptical in shape	Small, puckered, dry, round in shape
v. Pubic bones	Thin, flexible, well spread	Thick, hard, close-together
vi. Abdomen	Soft pliable, expanded, covered with velvety skin	Contracted, firm covered with thick skin
vii. Pigmentation	Bleached vent, eye ring, ear lobe, beak, shank	Yellow pigmentation in vent, ear ring, lobe, beak, shank
viii. Moult	Late but rapid	Early and slow
ix. Abdominal fat	Absent	Present

QUESTIONS

1. Define culling of chickens. Give differences of good and poor layers.
2. Write short notes on
   (a) Unproductive birds
   (b) Yellow pigmentation of shank
3. Tick the correct answer (√)
   (a) Culling of unproductive bird should be done in the evening. T/F
   (b) Yellow pigmentation of different parts of body of chicken is discharged due to heavy egg production. T/F
   (c) Shanks looses yellowness after 6-8 weeks of egg production in layers. T/F
   (d) Vent loses yellow pigmentation first at the start of egg laying. T/F

CHAPTER 11

Egg Production

Layer stocks are kept for commercial egg production. The rate of egg production is the most important factor and influences the feed cost of producing the eggs. The egg production can be measured individually or in the group. For commercial poultry farming flock record of egg production is maintained from economic point of view. Individual egg production is maintained in the breeding flock for selection purposes.

11.1 Measurements of Egg Production

11.1.1 Hen Housed Egg Production

Hen housed egg production is the average egg production in a flock and is calculated as the total number of egg produced in a specified period divided by the number of hens initially housed at the start of laying. In this case mortality and culling is not taken into account in the flock.

11.1.2 Hen Day Egg Production

This is calculated by dividing the total number of eggs produced in a laying cycle by the average number of hens in the flock after deduction of dead and culled birds. This figure will be always higher than the hen housed egg production.

11.2 Efficiency of Egg Production

Efficiency of egg production can be measured by calculating the amount of feed required to produce a dozen or one kg of eggs according to rate of lay and size of birds. The egg production is an inherited trait and is fully exhibited only when optimum environment and well balanced diet is available according to the requirements of the birds supported by optimum management. The target fixed in all India Coordinated Research Project for feed efficiency is 2 kg per dozen of egg i.e. 2 kg feed for production of a dozen of eggs of optimum size of 54-55 g each.

The first year egg production of the layer flock is affected by the following factors:

i. Age at first egg (sexual maturity)
ii. Rate of laying (Intensity and persistency of production)
iii. Persistency of production

iv. Pauses in production.
v. Amount of broodiness.

A hen is considered sexually mature when she lays her first egg. Good layers mature early i.e. at about 5 months of age. The more number of eggs a hen lays in a year more intense is her production. The hen lays eggs in clutches and a clutch consists of eggs laid in sequence on consecutive days without pause. The good layers lay in long clutches. Broodiness generally reduces egg production. It is a physiological character in which a hen starts sitting on the eggs laid by her and stops laying. Selection of non-broody hens reduces this phenomenon. Pauses in production reduces egg production. Sometimes poor management and worm infection also cause low egg production for which management practices must be checked and improved. The first laying year includes period of commencement of laying to the cessation of egg production at the onset of first complete moult. But good layers continue laying while moulting. The rate of lay at which the hen continues to lay is called persistency. The longer she remains in high egg production, the better egg producer she is. The hens of good persistency will continue to lay for 300 or more days from the time she has laid her first egg.

11.3 Production Under Summer Stress

Diverse climate causes stress to the birds. The stress may be due to physical, social and thermal factors. The thermal stress is manifested through a number of physiological responses. The direct effect of tropical climate shows that the egg production and egg quality go down in summer months. The indirect effect of tropical climate has been observed through lowered feed consumption, muscular fatigue, exhaustion and parasitic infestation. In broilers growth is affected due to stressful environments. Effect of environmental temperature above 29.5 °C has been reflected in reduced feed intake, increased water consumption, drop in egg production, thinner egg shell, reduced egg weight, poor feed utilization, early molt, threatened heat prostration and increased mortality.

QUESTIONS

1. Write short notes on
   (a) Hen housed (HH) egg production
   (b) Hen day (HD) egg production
   (c) Feed efficiency for egg production.
2. Name the factors influencing first year egg production.

3. Tick the correct answer (√)

(a) Broodiness reduces egg production. T/F

(b) Feed efficiency for egg production is about 2 kg/dozen of eggs. T/F

(c) Hen day egg production is always higher than hen housed egg production. T/F

(d) Good layers lay egg in long clutches. T/F

(e) Growth and egg production are adversely affected due to summer stress. T/F

CHAPTER 12

Artificial Insemination in Poultry

12.1 Importance

Artificial Insemination (AI) in poultry has received greater attention nowadays due to intensive system of poultry keeping. Most of the egg producers are now using cages for housing their birds. For getting fertile eggs from the birds kept in cages AI is the only suitable and effective method. Dilution of semen, utilizing the dilutors and storage of semen for longer period without impairment in its fertilizing capacity has added further importance of this technique in fowl.

In turkey breeding AI is the most useful method for getting fertile eggs. Species hybrids are only possible through AI like Chicken x Guinea fowl, Chicken x Quail and Fowl x Turkey hybrids. When there is physical incompatibility between mating pairs, AI is necessary to produce fertile eggs like dwarf dam line of broilers and normal male line.

12.2 Reproductive Organs

The anatomy and physiology of the reproductive system of chicken and turkey species in particular can preserve spermatozoa and retain their fertilizing powers for many days in the hen's oviduct. Semen is composed of spermatozoa suspended in the fluid seminal plasma. The fowl testes are situated in the anterior abdomen and even function at 45°C. The ductus epididymis is very short and spermatozoa are stored mainly in the distal part of the genital tract. No accessary glands are present but lymph folds secretion dilutes the semen via ejaculation.

The left ovary is functional in chicken. The cortex and medulla weigh about 6 g. Within the ovary about 2500 oocysts are visible to naked eye and 12,000 with a microscope.

12.3 Collection of Semen

Males used for natural mating if required for AI should be isolated from females for 7-10 days before semen is collected artificially.

An ordinary 4 to 5 cm in diameter glass or plastic funnel with blocked stem serves as a collection cup and a one ml tuberculin syringe is an ideal vehicle for inseminating measured quantity of semen into the oviduct of the hen.

12.3.1 One Man Technique

Cutting off the feathers surrounding the vent area of the male allows obtaining clean semen. In the simplest "one man" technique a single person seated or in a crouching position holds the male securing its legs between his knees. Initial excitation is produced by massaging the back of the male several times near the flashy tail. The legs can be felt to stiffen and the tail rises with a good massage, as a result erection of the copulatory appendages (Papillae) in the cloaca occur. At this time semen is squeezed from the swollen ejaculatory papillae in the collection cup held by the other hand by gently pressing inwards on the side of the cloaca with thumb and forefinger of the hand that was used for massage.

It is necessary to thrust the thumb and the forefinger deep into the soft part at the base of the pygostyle. While doing so the edge of the hand and the wrist flattens the tail down on to the back of the bird for visibility and ease of semen collection.

12.3.2 Two Man Technique

In "two man" method, one holds the birds by grasping its thighs along with some of the flight feathers to prevent wing flapping, in a horizontal position at a height convenient to the second person who concentrate on massaging and collection of semen by squeezing into the funnel.

In broilers due to their heavy body weight two man system may be more easy for collection of the semen.

Erection and ejaculation of semen from papillae is an immediate response to massage of back region of the male fowl and in the first ejaculation itself the bulk of the semen is obtained. Although a repeat massage and squeezing might yield some more semen. Squeezing the papillae too hard may rupture the vascular tissue and blood will appear in the semen. In such cases bird may be given rest for 4-5 days before making another attempt to collect semen.

Semen collection may be made as frequently as five times per week or 2, 3 or 7 days interval seems to be satisfactory.

12.4 Insemination of Hen

Usually insemination requires two men. One man with his left hand firmly holds lower thighs of the hen and with the right hand applies pressure on the abdomen below the cloaca to evert the vagina. The vaginal opening is on the left and intestinal opening is on the right side of cloaca. As the oviduct is everted the second man gently probes the insemination cannula into the oviduct to a depth of about 3 cm. The semen is released from the cannula as the pressure on the abdomen is released to allow the oviduct to resort to its normal position.

Flow sheet of semen collection and artificial insemination is given in fig.12.1.

12.4.1 Time of Insemination

The insemination is generally carried out in the afternoon hours between 14 to 19 hrs as most of hens would will be in proper place and empty. The presence of egg in uterus reduces fertility. Similarly, insemination

Semen Collection

Preparation of male

⇩

Feather clipping around the vent

⇩

Training of male

⇩

Holding the male

⇩

Stimulation by massage

⇩

Ejaculation of papillae and squeezing of papillae

⇩

Collection of semen in the cup

⇩

Semen evaluation (visual and microscopic)

⇩

Dilution if required

⇩

Loading of required amount of semen in the syringe

Insemination

Holding of hen

⇩

Eversion of oviduct

⇩

Spotting of vaginal opening

⇩

Introduction of syringe cannula

⇩

Deposition of semen deep in to the oviduct

⇩

Collection of fertile eggs after 48 hrs

Fig. 12.1 Semen Collection and Artificial insemination.

carried out just after laying of eggs, also reduces the fertility of the hens.

12.4.2 Semen Volume and Sperm Concentration

Semen volume varies between breeds, between males and also seasonally. The method of collection will markedly influence quality and density of semen. Normal semen physical characters are presented in table 12.1.

The season and breed wise data on semen volume and pH is presented in table 12.2

Semen from chicken can be obtained as early as 16-18 weeks of age but semen having good fertility is obtained after six months of age. The sperm concentration in turkey and pheasant is more than double than that of the chicken but semen volume is low.

12.4.3 Semen Volume and Sperm Concentration per Insemination

In natural mating 9-12% males are necessary to obtain optimum fertility. Using AI it may be reduced to 1.5-3% depending upon the technique adopted.

Dose of undiluted semen is 0.03-0.05 ml in chicken, duck and goose and 0.025 ml in turkey, whereas 0.015-0.025 ml in Japanese quail.

The increase in collection frequency may improve availability of semen volume, exact number of spermatozoa per week thus enhancing utility of this technique (Table 12.3).

12.4.4 Frequency of Insemination

The insemination in chicken is

TABLE 12.1
Semen Volume and Concentration

Species	Age at which semen can be collected (in weeks)	Mean volume (ml) with range	Sperm concentration x $10^8/mm^3$
Egg type chicken			
Light weight	24 - 32	0.15 (0.4 - 0.6)	5.0 (3.5 - 8.2)
Medium weight	26 - 28	0.20 (0.08 - 0.5)	5.0 (3.5 - 6.0)
Broiler chicken	26 - 28	0.35 (0.1 - 0.9)	5.7 (3.0 - 8.0)
Light weight	32 - 36	0.15 (0.08 - 0.30)	0.0 (8.0 - 14.0)
Heavy weight	32 - 36	0.20 (0.11 - 0.33)	9.5 (9.0 - 15.5)
Guinea fowl	28 - 30	0.075 (0.05 - 0.15)	6.0 (4.0 - 8.0)
Duck	26 - 30	0.23 (0.1 - 1.0)	4.0 (0.02 - 6.0)
Goose	26 - 30	0.52 (0.2 - 1.5)	0.25 (0.03 - 1.3)
Japanese Quail	8 - 10	0.1 ml	5 - 6

Figures in parenthesis are ranges

TABLE 12.2
Effect of Season on Semen Quality

	Winter	Summer	Rains	Average
White Leghorn				
Volume	0.57	0.49	0.55	0.53
pH	6.85	7.17	6.99	7.00
Cornish				
Volume	0.75	0.70	0.71	0.74
pH	6.73	7.54	7.07	7.11

TABLE 12.3
Effect of Sperm Concentration/volume on Number of Insemination

Collection frequency	Semen volume (Total)	Total sperm concentration x 10^{6} ml	A.I. per male (Dose 100 million sperm in 0.03- 0.05 ml Diluted semen)
5 x /week	1.85 ml	7.10	71
3 x /week	1.35 ml	4.92	49
1 x /week	0.35 ml	1.02	10

carried out at the interval of 5 - 7 days, duck 4 - 5 days, goose 6 days, Japanese quail 7 - 9 days and turkey 15 days. In chicken it is observed that after insemination maximum percentage of fertile eggs are obtained on 3rd day post insemination and fertility is maintained above 90%, up to 5 - 6 days. On an average the fertile eggs after first insemination may be obtained up to 10 days in chicken, 6 days in goose, 7 days in duck, 4 - 5 days in Japanese quail.

12.5 Precautions in Collection and Insemination

Males should be handled gently. When housed together it is desirable to mark the males which are good semen producers. When housed in cages individual cages are desirable. It is desirable to decomb the males if they are caged for AI. Feed may be withdrawn 4 - 6 hours before semen collection which will reduce the chances of faecal contamination of the semen. Adequate lighting in the area where semen is to be collected helps to make visual evaluation of the semen sample.

Factors influencing semen production in the fowls are light, nutrition, temperature and social interactions. While inseminating semen only trained staff should be allowed to inseminate.

The eversion of oviduct is more difficult when hard shelled egg is in the uterus. For best fertility the insemination is done in the late afternoon when most of the hens are without hard shelled eggs in the oviduct. Factors influencing fertility

by AI are number of spermatozoa inseminated, frequency of AI, quality of semen, cold shock during collection, technique of insemination, time of insemination, physiology of hen and condition under which semen is held in vitro. It must be remembered that during AI females should be handled very gently otherwise wrong handling will adversely affect egg production and fertility.

Weekly one insemination with 0.03 ml of good quality undiluted semen maintains good fertility. In summer months when semen quality is deteriorated due to high heat and humidity insemination at five days interval is desirable.

In the domestic hen the maximum duration of fertility is achieved when spermatozoa between 60 to 120 millions are inseminated. The number of spermatozoa required, however, varies from bird to bird and breed to breed.

12.6 Semen Evaluation

The objectives of semen evaluation in chicken are :

- to assess the fertilizing ability of breeder males
- to ensure good quality semen
- as a help in deciding storage and preservation of semen for long term use.
- to ensure fertility in inter-species crosses
- as a genetic tool in selection of males to improve semen quality and their fertilizing ability.

The most common semen quality evaluation traits are :

i. Semen appearance and colour
ii. pH of semen
iii. Volume of semen
iv. Motility of spermatozoa
v. Spermatozoa concentration per ml.
vi. Percentage of live and dead spermatozoa
vii. Percentage of abnormal spermatozoa
viii. Methylene Blue Reduction Test
ix. Sperm survival time at refrigerated temperature (4-5°C) or at higher temperature (46°C).
x. Determination of fertility and hatchability.

12.6.1 Semen Appearance and Colour

Thick creamy semen of good volume is indicative of high fertilizing capacity while very thin and watery semen indicates poor quality. Following colour and appearance scoring of semen is generally used (Table 12.4).

TABLE 12.4
Scoring Guideline for Semen Appearance and Colour

Appearance	Score
Watery or clear semen	1
Watery with white streak	2
Medium colour	3
Thick white	4
Viscous and chalky white	5

12.6.2 pH of Semen

pH of semen is measured by a standard narrow range indicator paper. One drop of freshly collected semen is placed on a strip of indicator paper and the colour developed is compared with standard colour to approximately determine the pH. The pH of fowl semen ranges from 6.3 to 7.8.

12.6.3 Volume of the Ejaculate

Volume of semen is determined by tuberculin syringe graduated up to 0.01 ml accuracy. It may range for 0.1 to 1.2 ml (Table 12.5).

TABLE 12.5
Volume of Semen per Ejaculation

Species	Amount
Cock	0.50 to 0.80 ml
Turkey	0.20 to 0.30 ml
Gander	0.05 to 0.60 ml
Drakes	0.26 to 0.33 ml

Only 0.03 ml of fresh semen is required for insemination of each female.

12.6.4 Motility of Semen

Higher initial motility is essential for better fertilizing capacity of the semen. In field conditions appearance score under microscope is enough to evaluate the semen quality (Table 12.6).

TABLE 12.6
Motility Score

Appearance score under microscope	Score
95% motile, swirling, progressive, vigorous sperm	+5
Mostly motile, little swirling, less vigorous, less progressive motion of sperms	+4
50% motile, no progressive motion, extremely sluggish sperms	+3
5-10% motile, no progressive motion of sperms	+2
less than 5% motile, no motion of sperms	+1
None motile sperms	0

12.6.5 Spermatozoa Concentration

Only if spermatozoa concentration is known accurately, the rate of dilution, and number of females that are to be inseminated, can be fixed to keep fertility of the flock high. Haemocytometer or Spectophotometer methods are used to find out the spermatozoa concentration in the semen. It ranges from 1.7 million to 6.7 million/mm^3.

12.6.6 Percentage of Live and Dead Spermatozoa

This is an indicative of viability of semen. Fertility drops with increase in percentage of dead spermatozoa in the semen. The mean live sperms varies from 70 to 80 % in fresh good quality semen.

12.6.7 Percentage of Abnormal Spermatozoa

In a good semen there should not be many abnormal spermatozoa. The deviation from normal morphology can be at *(i)* head-enlarged head, coiled head, broken head, etc; *(ii)* mid piece-filiform mid piece, broken mid piece, and *(iii)* tail-absence of tail, broken, coiled or twisted tail. There should not be more than 10% abnormalities in a semen sample.

12.6.8 Methylene Blue Reduction Time Test (M.B.R.T.)

It is an important aspect of analyzing the metabolic activity. The principle is the presence of dehydrogenase enzyme systems like succinic acid dehydrogenase in semen which releases hydrogen ions. These

hydrogen ions are accepted by methylene blue dye and in this process it gets reduced. The less the time taken the more is the metabolic activity. The average MBRT in White Leghorn semen has been reported as 17.6 to 26.4 minutes using 0.05 ml of undiluted semen.

12.6.9 Survival Time

Survival time of spermatozoa at refrigerated temperature of 4.5°C and also at high ambient temperature of 46°C can also serve as a quality criterion in evaluating semen samples. Average survival time of RIR spermatozoa at 4°C varied from 6.3 to 9.1 days, while at 46°C, it was only nearly 7.5 hours.

12.6.10 Determination of Fertility and Hatchability

Since this is the ultimate aim of semen quality, it is always wise to test males fertility and hatchability by insemination of the semen in a random sample of females and determining the onset, duration and extent of fertility as well as percentage of hatchability, though this is a costly and time consuming test.

12.7 Storage of Semen

Improved semen storage technology in the recent years has helped the poultry industry in many ways like that of the semen from selected and elite males can be stored for indefinite period. The endangered and vanishing avian species can be saved by storing semen in frozen state for redistribution in years to come. In future if international selection goals for poultry breeding become more critical, the frozen semen can be introduced from one country to other country. The use of preserved semen eliminates the risk of expenses of transportation of live birds for breeding.

As soon as semen is ejected from the male a proportion of spermatozoa begins to lose their integrity. Researches on diluents and storage techniques are aimed to provide as far as possible best conditions for their maintenance. If semen is to be stored beyond an hour, spermatozoa must be *suspended in a synthetic diluent.* Semen should not be exposed to bright sunlight or heat, neither be subjected to evaporation before use. Semen should be used immediately after collection. It should not be stored more than an hour. For storing more than an hour it should be diluted. Diluents are ideal media for growth of bacteria and moulds. Hence they should be stored in a refrigerator. Freeze dried preparations may be kept for longer periods. The temperature of the semen and diluent must be equalised before mixing.

Diluted fowl semen when stored at 2 to 5°C has yielded good fertility after 24 hours of storage. Following points are essential if diluted stored semen is to be used.

i. Dilution of semen should be properly done and insemination dose must contain minimum number of spermatozoa required for fertility.
ii. The cleanliness of semen is most important.
iii. The holding temperature and time

must be according to the composition of the diluent.

The application of AI in poultry has been enormously increased with the introduction of frozen semen technique. Investigations have been carried out to store poultry semen at sub zero (-196°C) temperatures. Fowl semen is diluted to contain 15-20% glycerol and it can be frozen to -79°C and thawed at 40°C without impairing motility of spermatozoa.

12.8 Cryopreservation

Freezing cellular material like spermatozoa without affecting its fertilizing ability is called cryopreservation. Cryoprotective agents are essential for cryopreservation. It is essential to have correct diluent, cryoprotective agent, containers for semen and the proper method of freezing (including the freezing and thawing rates) for each species of bird to get maximum number of viable spermatozoa after cryopreservation. Glycerol is an effective cryoprotective agent for preserving fowl spermatozoa at -79°C. But glycerol as cryoprotective agent damages spermatozoa at ambient temperatures and must be removed after thawing and before insemination to obtain proper fertility.

More studies are needed to improve the recovery of viable spermatozoa after defreezing and thawing. The effect of various steps in the procedure of freezing and thawing on the various sperm membranes, including mitochondrial cristae, intra cellular compartments and other components of the spermatozoa needs to be studied.

12.8.1 Freezing Fowl Semen

Place 0.15 ml uncontaminated fresh good quality semen in small tube. Cool these tubes to 3-5°C for 3 minutes. Add 0.45 ml of cold glycerolised diluent and mix quickly and gently. Put 0.6 ml mixture in cold 1 ml ampoules for freezing. Seal the ampoules. Place the ampoule in a rubber test tube holder immersed in a cold water bath. The level of water in this bath should be close to the top of the neck of the ampoules so that when sealing the tip with blow torch the temperature does not rise inside the ampoule. Use a glass rod to draw out the melting tip of the ampoule to aid in shortening the time of sealing. Place the ampoules in cans and immerse in cold alcohol (96%) bath. Transfer these cans in freezing apparatus without allowing temperature to rise and freeze these ampoule at the rate of 1°C/minute up to -35°C. Place immediately in to the liquid nitrogen. Do not allow the temperature to rise when transferring to liquid nitrogen at -196°C where sperms can remain indefinitely.

12.8.2 Thawing and Insemination

Take out the cans containing ampules from liquid nitrogen container and put in to the cold alcohol bath. Agitate the cans to disperse ice as rapidly as possible. Transfer semen using pasture pipette from ampoules to a round bottom centrifuge tube immersed in water bath at 5°C. The composition of diluent is -

1.92 g sodium glutamate monohydrate.
0.60 g fructose

0.08 g magnesium acetate (tetrahydrate)
0.128 g pot. citrate monohydrate and 0.51 g anhydrous sodium acetate made up in distilled water to 100 ml.

Add the following volume of cold non-glycerolised diluent 0.08, 0.22, 0.40, 0.73, 1.5 and 1.9 ml. Mix the mixture between each addition of diluent by gently sucking the mixture. Centrifuge at 1,600 RPM for 15 minutes at 5° C. Remove the supernatent with pasture pipette and add 0.1 ml cold non glycerolised diluent and suspend spermatozoa by flicking test tube with finger. Semen is now ready for insemination. Inseminate the same deep intravaginally into the hen. Insemination must be carried out within 15 minutes. Fertility may be estimated after 48 hrs of insemination by collecting eggs and incubating the eggs in the incubator.

12.9 Formation of Egg

At sexual maturity ova are released from the ovary and enter the oviduct. This process is called ovulation.

When an ovum is matured the progestrone hormone produced by the ovary, excites the anterior pituitary to cause the release of Lutenizing Hormone (LH) which in turn causes the mature follicle to rupture at the stigma to release the ovum with yolk from the ovary. The ovum (yolk) is surrounded by only the yolk membrane. Each hen lays successive yolk more or less of the same shape.

The oviduct is a long tube through which ovum (yolk) passes and all other portions of an egg are formed. The different segments of oviduct are Infundibulum, Magnum, Isthmus, Uterus, Vagina, Cloaca, and Vent.

The infundibulum is funnel shaped and when functional its length is about 9 cms. It engulfs the yolk, and then it enters the oviduct. The yolk remains in this section for only 15 minutes and then is forced to Magnum. The albumen is secreted in this portion. Magnum is about 33 cm long. It takes about 3 hours for the developing egg to pass through the magnum after which it is forced into Isthmus. Isthmus is about 10 cm in length where the egg stays for about 75 minutes. Here inner and outer shell membranes are formed in such a manner as to give final shape of the egg. Then it is passed into uterus or shell gland. It is about 10-12 cm long in laying hen. The developing egg remains in the uterus for about 18 to 20 hours. When egg enters the uterus water and salts are added through the shell membrane by osmosis. Egg shell calcification begins. Small clusters of calcium appear on the outer shell membrane just before the egg leaves Isthmus. The first shell is deposited over the cluster of the calcium that appears on shell membrane which is composed of calcite crystals, a sponge like material. This layer is followed by the addition of outer shell about twice as thick as the inner shell and is made up of hard calcite crystals. The completed egg shell is made up of mostly calcite crystals which is made up of calcite ($CaCO_3$) with small deposits of sodium, potassium and magnesium. As soon as the egg shell is completed the egg is forced into vagina which is about 12 cm in length.

Here cuticle is deposited on the shell to fill many small shell pores. Egg stays only for four minutes in the vagina and is laid through vent (oviposition).

When the egg is first laid there is no air cell. However it soon appears and increases in diameter to about 1-2 cms. As the egg becomes old, the interior contents dehydrate and the size of air cell increases in diameter and depth.

QUESTIONS

1. Write the advantages and disadvantages of AI in chicken.
2. Give a flow sheet of semen collection from cock.
3. Name the most commonly used semen quality evaluation test of Cock semen.
4. Make a suitable diagram of female reproductive system of chicken and give the function of each part.